REVISED QUALITY ASSURANCE PROJECT PLAN (QAPP)

PROJECT:

QUARTERLY GROUNDWATER MONITORING AND SUBSURFACE INVESTIGATION AT THE MISSOURI ELECTRIC WORKS (MEW) SITE, CAPE GIRARDEAU, MISSOURI

Prepared For:
MEW Site Trust Fund Donors
c/o Ameren Services
One Ameren Plaza
1901 Chouteau Avenue
PO Box 66149, MC 602
St. Louis, MO 63166-6149

Prepared By:
KOMEX•H2O SCIENCE•INC
5455 Garden Grove Blvd., Second Floor
Westminster, CA 92683-8201 USA

August 23, 2002

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USA

Dated: August 23, 2002

Project: 093-001C

Expiration Date: August 31, 2003

QUALITY ASSURANCE PROJECT PLAN (QAPP)
TITLE AND APPROVAL SHEET

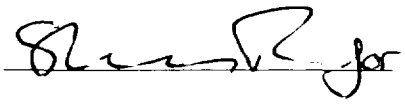
PROJECT: QUARTERLY GROUNDWATER MONITORING AND SUBSURFACE INVESTIGATION AT THE MISSOURI ELECTRIC WORKS (MEW) SITE, CAPE GIRARDEAU, MISSOURI

SITE LOCATION: 824 SOUTH KINGSHIGHWAY, CAPE GIRARDEAU, MISSOURI (EPA ID: MOD980965982)

PREPARED FOR: MISSOURI ELECTRIC WORKS SITE TRUST FUND DONORS

c/o AMEREN SERVICES

PREPARED BY: KOMEX

APPROVED BY:	SIGNED (& date)	NAME
Project Manager		Paul Hardisty, Ph. D.
Project Quality Assurance Manager		Robert L. Traylor, R.G., C.Hg.
USEPA Project Manager		Pauletta France-Isetts
USEPA Quality Assurance Manager		

MEW Site File
Break7_033866

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF ABBREVIATIONS

°C	Degrees Celsius
°F	Degrees Fahrenheit
%	Percent
uS/cm	Micro-Siemens Per Centimeter @ 25°C
ug	Micrograms
ug/L	Micrograms per Liter
AES	Analytical Environmental Services, Inc.
bgs	Below Ground Surface
BOD	Biochemical Oxygen Demand
CFR	Code of Federal Regulations
CHSP	Corporate Health and Safety Plan
cm	Centimeter
COCF(s)	Chain-of-Custody Form(s)
COC	Chemicals of Concern
CVOCs	Chlorinated Volatile Organic Compounds
d	Days
DQOs	Data Quality Objectives
FPM	Field Project Manager
ft	Feet
g	Gallons
GC/MS	Gas Chromatogram/Mass Spectrophotometer
gm	Grams
HaSP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations Procedure and Emergency Response
HCl	Hydrochloric Acid
HCS	Hazard Communication Standard
HNO_3	Nitric acid
hr	Hour
in.	Inches
KCl	Potassium Chloride
kg	Kilograms
km	Kilometers
L	Liters

lbs	Pounds
LCS	Laboratory Control Sample
LQMP	Laboratory Quality Management Plan
m	Meters
MCL(s)	Maximum Contaminant Limit(s)
MDL(s)	Minimum Detection Limit(s)
MDNR	Missouri Department of Natural Resources
MEW	Missouri Electric Works
mg	Milligrams
mg/l	Milligram per litre
mg/kg	Milligrams per kilogram
min	Minutes
ml	Milliliters
mm	Millimeters
MSDR	Matrix Spike Duplicate Recovery
MSR	Matrix Spike Recovery
NA	Not applicable
$Na_2S_2O_3$	Sodium bisulphate
NIST	National Institute of Standards and Technology
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
oz	Weight in Ounce/s
PCB(s)	Poly-Chlorinated Bi-phenyl(s)
PCR	Project Consistency Reviewer
PCTM	Project Chemistry Task Manager
PDM	Project Database Manager
PFT	Project Field Team
pH	Hydrogen ion (H^+) concentration as -log[H^+] in mol/liter
PHSO	Project Health and Safety Officer
PM	Project Manager
PQAM	Project Quality Assurance Manager
QA	Quality Assurance
QAPP(s)	Quality Assurance Project Plan(s)
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
QRB	Quality Review Board

RPD	Relative Percent Difference
s	Seconds
SA	Spiked Analyte
SAP	Sampling and Analysis Plan
SHSO	Site Health and Safety Officer
SOPs	Standard Operating Procedures
SR	Sample Result
SRM	Standard Reference Material
SSR	Spiked Sample Result
STFD	Site Trust Fund Donors
SVOCs	Soil volatile organic compounds
t	Tons
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
yr	Years

1 PROJECT MANAGEMENT

1.1 DISTRIBUTION LIST

The following individuals and their organizations will receive copies of the approved Quality Assurance Project Plan (QAPP) and any subsequent revisions:

- Pauletta France-Isetts, United States Environmental Protection Agency (USEPA) Region 7 RPM;
- Warren Mueller, Ameren Services*;
- Chuck Hunnewell, Siemens Inc.*;
- Sandra Rudolph, Jacobs*;
- George von Stamwitz, Ameren Services*;
- David Sanders, Black and Veatch Inc.*;
- Don Van Dyke, Missouri Department of Natural Resources (MDNR)*;
- Jeff Imes, United States Geological Survey (USGS)*;
- Komex Project File for internal use; and
- Komex Field Book: for field personnel use.

*: These individuals are receiving copies of the QAPP and subsequent revisions in an informational capacity. These individuals do not have project responsibilities or duties.

1.2 PROJECT/TASK ORGANIZATION

This QAPP has been prepared by Komex for Missouri Electric Works (MEW, referred to as the "Site"), Site Trust Fund Donors (STFD) and Ameren Services. This section describes the roles and responsibilities of project team members that will be involved in the implementation of the Quality Assurance/Quality Control (QA/QC) program. The QA/QC hierarchy for this project is outlined in **Figure 1**.

1.2.1 PROJECT MANAGER (PM)

The Project Manager (PM) has overall responsibility for the implementation of QA/QC measures included in this QAPP. The PM is responsible for the overall design and implementation of the project including development and implementation of the Project Work Plan, assuring that the specific field methods and analytical methods included in the QAPP

and Sampling and Analysis Plan are appropriate and that the Health and Safety Plan is adhered to.

1.2.2 PROJECT QUALITY ASSURANCE MANAGER (PQAM)

The Project Quality Assurance Manager (PQAM) is responsible for project quality assurance (QA). The PQAM will review all aspects of the Work Plan and SAP prior to implementation of the field program. The PQAM will endeavor to ensure that adequate QA procedures are incorporated into the Work Plan and SAP to allow for the collection of data of acceptable quality for the intended use. The PQAM will update the QAPP as required. The PQAM is responsible for evaluating the impact on data quality of any significant deviations from the Work Plan or SAP reported by the Field Project Manager (FPM). The result of any such evaluation will be reported in writing to the PM. The PQAM will conduct QC evaluations of the laboratory methods being used for the analytical work. The PQAM will work closely with the laboratory representatives and the project team to ensure measurement performance criteria are met. Any significant laboratory deviation from the criteria will be reported to the PM and the Project Chemistry Task Manager (PCTM). The PQAM has the authority to suspend studies if the project quality objectives are being violated and will notify the PM in writing upon taking such action.

1.2.3 PROJECT CONSISTENCY REVIEWER (PCR)

The Project Consistency Reviewer (PCR) assists the PQAM with chemistry validation by verifying that associated sample data information reported by the laboratories is consistent with data collected in the field. This person also verifies that electronic data and hard copy reports provided by the laboratories are consistent.

1.2.4 FIELD PROJECT MANAGER (FPM)

The FPM is responsible for overseeing the implementation of the field activities in accordance with the Work Plan, SAP and the QAPP. The FPM's specific responsibilities will include:

1. Communicating task objectives to task managers and task members;
2. Distributing the Work Plan and SAP to members of the team; and
3. Answering any questions regarding the sampling program.

In addition, the FPM is also responsible for documenting and notifying, in writing, the PM and PQAM of any deviations from the Work Plan or SAP that occur during field sampling.

1.2.5 PROJECT HEALTH AND SAFETY OFFICER (PHSO)

The Project Health and Safety Officer (PHSO) is responsible for preparation, implementation and updating of the HaSP. Further details regarding health and safety personnel may be provided in the accompanying **Revised HaSP (Komex, 2002)**.

1.2.5.1 Health and Safety Plan

A Site specific HaSP, based upon the Komex Corporate Health and Safety Plan (CHSP), will be prepared prior to the start of each phase of field work (currently, **Komex 2002**). This health and safety plan will conform to applicable regulatory requirements including, but not limited to, Section 29 of the Code of Federal Regulations (CFR) 1910.120 and 1926.59 as administered by the Federal Occupational Health and Safety Administration (OSHA). The following sections are included in this plan:

- Project background and scope-of-work;
- Project safety personnel, assignments and responsibilities;
- A Site hazard analysis, including: general safety hazards, physical hazards, biological hazards and chemical hazards;
- General health and safety requirements and controls to mitigate risk, including: medical clearance, safety orientation, work zone designation and personal protective equipment and clothing;
- Exposure monitoring;
- Decontamination procedures;
- General work practices;
- Standard operating procedures;
- Training requirements;
- Medical surveillance program;
- Record keeping;
- Emergency response procedures, including: physical injury, fire, explosion and property damage, emergency telephone numbers, work site address and contacts, hospital address and route and standard procedures for reporting emergencies; and
- Hazardous materials information.

Field work will be performed in accordance with the HaSP as approved by the client, MDNR, and USEPA. Komex will conduct its operations in such a way as to avoid risk or bodily harm to persons or damage to property.

Komex will designate a Site Health and Safety Officer (SHSO). The SHSO, or their designated representative, will be present at the Site during field activities. Both persons will be familiar with hazardous waste laws and regulations in Missouri and with OSHA requirements.

1.2.5.2 Health and Safety Training

Komex and subcontractor personnel working at a Site will have received OSHA 40-hour health and safety training in accordance with the requirements of the USEPA and State of Missouri, the OSHA requirements for Hazardous Waste Operations Procedure and Emergency Response (HAZWOPER) as found in 29 CFR 1910.120 and Hazard Communication Standard (HCS) as found in 29 CFR 1910.1200. In addition, field personnel will have received the required 8-hour refresher training courses to remain current. Copies of the certificates for the 40-hour and 8-hour HAZWOPER courses for field personnel working at the Site will be maintained in the project files at Komex's office.

1.2.6 PROJECT FIELD TEAM (PFT) MEMBERS

The Project Field Team (PFT) Members are responsible for reviewing and understanding the Work Plan, SAP, QAPP, HaSP, any amendments to these documents, and particularly the field sampling procedures described in the Work Plan and SAP. PFT Members are responsible for directing any questions about the field procedures to the FPM.

1.2.7 PROJECT CHEMISTRY TASK MANAGER (PCTM)

The PCTM reviews the Work Plan, SAP and QAPP and any amendments to these documents, assuring that the field and analytical chemistry methods are appropriate, and evaluating the impacts of any deviations from the Work Plan. The PCTM will be kept informed of analytical laboratory deviations by the PQAM. Significant impacts from deviations in the field methods or Work Plans to chemical data quality will be reported to the PM by the PCTM.

1.2.8 LABORATORY MANAGER

The Analytical Environmental Services, Inc. (AES) Laboratory Manager is responsible for all laboratory analytical methods, protocols and QA/QC. The Laboratory Manager will interface

directly with the PQAM and/or PM and will notify the PQAM and/or PM of any deviations from standard lab protocols and methods.

1.3 PROBLEM DEFINITION/BACKGROUND

1.3.1 PROBLEM DEFINITION

The scope of work to be guided by this QAPP is intended to establish a database of groundwater quality under the current undisturbed conditions, and to investigate and delineate potential isolated chemicals of concern (COC) impacted areas in the shallow aquifer. It is likely that the previous environmental investigations, including drilling into the bedrock and conducting pumping tests, have lead to disturbance of the hydrogeological regime, and remobilization of COC. Given that until 2000 the only groundwater monitoring was performed over a decade previously, development of a more continuous data-set is highly desirable. In addition, groundwater monitoring data reflecting post soil remediation conditions will be useful for Site evaluation. A large volume of impacted soil was removed and treated and it is expected that concentrations of COC in groundwater beneath the Site will decrease over time. Additional groundwater monitoring data would provide the opportunity to discern any trends in groundwater quality, which may occur.

The previous year of groundwater monitoring has indicated that some zones in the aquifer are displaying decreasing trends in COC concentrations, particularly at depths greater than 100 feet (30.5 meters [m]) below ground surface (bgs). However, isolated areas of impacted groundwater may potentially exist in the shallow zone of the limestone aquifer **(Komex, 2002a)**. It is proposed to install additional groundwater monitoring wells to the presence (or absence) of COC at depth and down gradient of the impacted areas.

1.3.2 BACKGROUND

Site background is presented in **Section 2 of the Revised Work Plan (Komex 2002a).**

1.4 PROJECT/TASK DESCRIPTION

1.4.1 TASKS TO BE PERFORMED

A full description of work is outlined in **Section 4.0 of the Revised Work Plan (Komex 2002a)** for the quarterly groundwater monitoring and subsurface investigation. The following tasks are defined here, with explanations provided in **Section 4.0 of the Revised Work Plan (Komex 2002a)**:

- Groundwater monitoring;
  - o Data logger quarterly downloads;
  - o Monitoring well gauging, purging, and sampling;
  - o Laboratory analyses;
- Rainfall monitoring and quarterly downloads;
- Subsurface Investigation;
  - o Installation of three groundwater monitoring wells in the shallow limestone aquifer to a depth of 55 to 65 feet (16.8 to 19.8 m) and/or the weathered/competent limestone rock interface;
  - o Development, purging, and sampling of the installed monitoring wells; and
- Reporting.

1.4.2 FIELD MEASUREMENTS TO BE COLLECTED

Field activities include the following measurements and observations that will be conducted in accordance with protocols outlined in the accompanying **Revised SAP (Komex 2002c)**:

- Groundwater monitoring;
  - o Measurements of depth to water during groundwater sampling;
  - o Measurement of water quality parameters during groundwater sampling;
- Subsurface Investigation;
  - o Description of soil samples collected during borehole advancement for lithologic, hydrogeologic, and geotechnical properties using the United Soil Classification System (USCS);
  - o Headspace analysis of soil samples for volatile organic compounds (VOCs), using a field photo-ionization detector;
  - o Measurement of the volume of water added during borehole advancement;
  - o Inspection of limestone cores, collected during the advancement of the above boreholes, for fracture analysis;
  - o Measurements of depth to water during monitoring well installation; and
- Health and Safety organic vapor monitoring equipment.

1.4.3 APPLICABLE STANDARDS, CRITERIA, AND OBJECTIVES

Applicable standards for this project primarily include the drinking water maximum contaminant levels (MCLs) for COC in groundwater. All laboratory method detection limits (MDLs), see **Section 4.1.3 of Revised Work Plan (Komex 2002a)** and **Appendix A** of this QAPP, are below the MCLs and are therefore adequate for this project, as displayed below in Table 1.

Table 1: Chemical and Physical Analytes.

Analyte	USEPA Method	Method Detection Limit (mg/L)
Alkalinity	310.1	0.034
Chemical Oxygen Demand	410.2	5.0
Total Organic Carbon	415.1/9060	0.46
Total Dissolved Solids	2540C	Not applicable (NA)
Total Suspended Solids	160.5/2540E	NA
Specific Conductance	120.1/2510B	
Biological Oxygen Demand	405.1	
Hardness, Total	130.2/2340B	NA
Anions		
Calcium	200.7	
Iron	200.7	
Magnesium	200.7	
Potassium	200.7	
Sodium	200.7	
Cations		
Chloride	300.0	0.054
Nitrate	300.0	0.066
Sulfate	300.0	1.7
Volatile Organic Compounds	8260B	< 0.005
Semi-volatile Organic Compounds	8270C	< 0.010
Polychlorinated Biphenyls (Liquids)	8082	0.000054 – 0.000090
Polychlorinated Biphenyls (Solids)	8082	0.057 – 0.070 milligrams per kilogram (mg/kg)

1.4.4 SPECIAL PERSONNEL OR EQUIPMENT REQUIREMENTS

The installation of additional groundwater monitoring wells will be performed by Phillips Services Corporation, Illinois, a Missouri-licensed drilling contractor. The boreholes will be advanced using a CME 75 hollow stem auger drilling rig, which will be converted to perform coring into the competent limestone bedrock. Komex will oversee and direct drilling operations in accordance with the current **Revised Work Plan (Komex, 2002b), Revised SAP (Komex, 2002c) and Revised HASP (Komex, 2002).**

1.4.5 ASSESSMENT TOOLS NEEDED

Field assessment tools will include the following:

- A pH, electrical conductance, temperature and turbidity meter for measuring groundwater parameters during groundwater purging and well development;
- A water level sounder for measuring depth to water in groundwater wells; and
- A Photo-ionization detector, organic vapor analyzer or flame ionization detector for HaSP vapor monitoring.

1.4.6 WORK SCHEDULE

The work schedule is outlined in **Section 5.0 of the Revised Work Plan (Komex 2002a)** associated with this QAPP.

1.4.7 REQUIRED PROJECT AND QUALITY ASSURANCE RECORDS/REPORTS

Data and analysis generated during this investigation and associated QA/QC documentation will be reported as described in **Task 4 of the Revised Work Plan (Komex 2002a)** submitted with this QAPP.

1.5 DATA QUALITY OBJECTIVES FOR COLLECTION AND MEASUREMENT OF DATA

Project data quality objectives (DQOs) have been designed with the primary purpose of successfully meeting the goals of the project outlined in **Section 3.0 of the Revised Work Plan (Komex 2002a)**. The overlying DQO is to collect data that will assist in resolving, with a minimum degree of uncertainty, whether COC are currently present in groundwater and if so, beginning to understand their fate and transport within the governing hydrologic system.

The overlying DQO relies on the goal that concentrations of COC reported in critical groundwater samples are representative of conditions within the appropriate monitoring wells. This in turn requires that QA/QC and SAP procedures for both field and laboratory work are adhered to in a satisfactory manner and that QA objectives are met.

The QA objectives are to collect representative samples and measurements that can be analyzed in an accurate and precise manner providing results in a standard, comparable format. AES, a USEPA approved laboratory, will perform all routine chemical analyses as well as QA/QC samples. The QAPP for AES is presented in **Appendix A**.

Ground water samples will be analyzed using the appropriate USEPA methods as outlined in the **Revised Work Plan in Sections 4.1.3, 4.3.4 (Komex 2002a)** and in the following **Table 2**.

Table 2: USEPA Analysis Methods

Analyte	USEPA Method	Practical Quantification Limit (mg/L)	Method Detection Limit (mg/L)
Alkalinity	310.1		0.034
Chemical Oxygen Demand	410.2		5.0
Total Organic Carbon	415.1/9060		0.46
Total Dissolved Solids	2540C		
Total Suspended Solids	160.5/2540E		NA
Specific Conductance	120.1/2510B		
Biological Oxygen Demand	405.1		
Hardness, Total	130.2/2340B		NA
Anions			
Calcium	200.7	0.1	
Iron	200.7		
Magnesium	200.7	0.1	
Potassium	200.7	0.5	
Sodium	200.7	1.0	
Cations			
Chloride	300.0		0.054
Nitrate	300.0		0.066
Sulfate	300.0		1.7
Volatile Organic Compounds	8260B	0.005 to 0.010	< 0.005
Semi-Volatile Organic Compounds	8270C		< 0.010
Polychlorinated Biphenyls (Liquids)	8082	0.001 to 0.002	0.000054 to 0.000090

Polychlorinated Biphenyls (Solids)	8082	0.001 to 0.067 mg/kg	0.057 to 0.070 mg/kg

This document describes the protocols in place to ensure the quality of the data. The goals for assessing precision and accuracy in laboratory measurements are consistent with those put forth in the USEPA Test Methods For Evaluating Solid Waste (1986) and USEPA Methods For Chemical Analysis of Water and Wastes (1979). If USEPA methods other than those contained in USEPA (1986) and USEPA (1979) are used, laboratory goals for precision and accuracy will be consistent with those put forth by USEPA (1986).

Representative field and laboratory data will be collected through the use of consistent methods for field installations and testing, and sample collection, preservation, transportation, and analysis. These methods are provided in the accompanying **Revised SAP (Komex, 2002c)** and include, but are not limited to, the following surface and subsurface soil protocols:

- Water protocols;
- Measurement of field parameters;
- Sampling of groundwater monitoring wells;
- Advancement of boreholes, soil analysis and sampling; and
- Installation of groundwater monitoring wells.

Comparability of data throughout the project will be attained by recording field and laboratory data in consistent units, as well as following the protocols outlined in the **Revised Work Plan (Komex, 2002b)** and **Revised SAP (Komex, 2002c)** for collecting and analyzing samples. Parameters commonly measured in this type of project and their associated units are listed below in Table 3:

Table 3: Common parameters and units used

Parameters	Units
Length	Inches, feet (ft), miles
	Millimeters (mm), centimeters (cm), meters (m) and kilometers (km)
Volume	Length^3 or gallons (g), milliliters (ml) and liters (L)
Area	Length^2 or acre hectare and square meters
Time	Seconds (sec), minutes (min), hours (hr), days (d), years (yr)
Weight	Micrograms (ug), milligrams (mg), grams (gm), kilograms (kg)
	pounds (lbs), tons (t)
Depth	feet (ft) and meters (m) bgs

pH	pH units
Temperature	degrees Fahrenheit (°F) and degrees Celsius (°C)
Specific Conductance	micro-Siemens per centimeter @ 25 °C (uS/cm)
Concentration, Water	micrograms per liter (ug/L)
Concentration, Soil	milligrams per kilogram (mg/kg)

1.5.1 PRECISION

Precision is defined as a measure of agreement among individual measurements of the same property. Sampling precision may be defined by collecting and analyzing field duplicate samples. Laboratory precision may be defined by analyzing duplicate samples (matrix spike/matrix spike duplicate samples for organic analyses). Comparison of duplicate samples is performed by calculating percent (%) differences between the sample results. Percent differences, up to 30% for aqueous samples and up to 50% for soil samples, are considered acceptable.

1.5.2 ACCURACY

Accuracy is defined as the degree of agreement of a measurement or average of measurements with an accepted or true value. Accuracy measures bias in the determination of values and is best established by analysis of blanks, spikes and continuing calibrations. Bias can result from sampling protocols or analytical procedures. While laboratory, field or equipment blanks may easily reveal a positive bias, a negative bias due to a loss of target analytes may be almost impossible to measure.

1.5.3 REPRESENTATIVENESS

Representativeness is defined as an expression of the degree to which the data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition or an environmental condition. Representativeness is a qualitative parameter that is most controlled by the proper design of the sampling program. The PFT members are responsible for collecting samples representative of the media being sampled and following field procedures described in the **Revised Work Plan (Komex, 2002b)** and **Revised SAP (Komex, 2002c)**. Representativeness can be assessed by the use of field duplicate samples. Duplicate samples are collected so that they are equally representative of a given point in time and space. Therefore, they measure both precision and representativeness.

1.5.4 COMPLETENESS

Completeness is defined as a measure of the amount of valid data collected from a measurement system as compared with the amount that was expected to be collected. Completeness for techniques performed in the laboratory will be defined as 100%, but may be modified in amendments to this QAPP. Completeness in regard to the critical portions of this field program will be defined as all Site groundwater wells that can be sampled will be sampled in accordance with the SAP.

1.5.5 COMPARABILITY

Comparability is defined as an expression of the confidence with which one data set can be compared to another. Sample data should be comparable with other measurement data for similar samples and sample conditions and to data collected during previous investigations at the Site. Details for achieving this comparability are as follows:

- Data units will be expressed uniformly for each parameter, and
- All soil concentrations will be reported on a dry basis.

The variability associated with the data in terms of precision, accuracy and representativeness will also be assessed and included as part of the data quality discussion in the QA section of any report.

1.6 SPECIAL TRAINING REQUIREMENTS/ CERTIFICATIONS

All personnel required to be on-site at the MEW facility will be in compliance with Section 5.3.2 of the accompanying HaSP in regard to special training requirements and or certification. There are no special training or certification requirements beyond those to comply with the HaSP.

1.7 DOCUMENTATION AND RECORDS

1.7.1 FIELD OPERATION RECORDS

Field operation records will document the overall field operations and any unusual conditions which may exist at the Site. These records will consist of the following:

- Daily Field Activity Report

  Each sampling crew will write a daily field activity report, which summarizes the activities at the Site. Information presented in the daily field logs will include the following:

- Date;
- List of all sampling personnel and responsibilities/duties;
- Time of arrival at Site;
- General weather conditions (i.e. rain, snow);
- Total number of samples and sample identification numbers for all samples collected;
- Any significant problems or unusual situations encountered while sampling; and
- Time of departure from Site.

- Field Sampling Notebooks

  Each sampling crew will document in a field sampling notebook details of the location and the collection procedure for each sample. Information which will be noted in the field sampling log for each sample includes the following:

  - Sample identification number;
  - Date;
  - Time of collection;
  - Type of sample (i.e. soil pile, soil borehole, monitoring well);
  - Sample location; and
  - Any unusual problems or observations while collecting samples.

- Chain-of-Custody Records

  Field personnel will be responsible for completing a Chain of Custody Form (COCF) including the following information:

  - Matrix;
  - Sample identification number;
  - Date;
  - Project name and number;
  - Sampler's initials;
  - Time of collection (military time);
  - Type of sample (grab or composite);
  - Number of samples;
  - Volume of containers;
  - Analysis request;
  - Preservation methods; and

- Remarks.

- Sample Tags

  Each sample sent to the laboratory will have a sample seal securely fastened to the sample container. The sample seals will include the following information:

  - File number;
  - Project number;
  - Hole number (if applicable);
  - Sample number;
  - Sample depth;
  - Date collected;
  - Inspector's initials; and
  - Remarks.

- Quality Control Sample Records

  Field personnel will be responsible for completing a Quality Control (QC) Sample Record including the following information:

  - Matrix;
  - Sample identification number;
  - Date;
  - Project name and number;
  - Sampler's initials;
  - Type of QC sample (field, trip, equipment rinsate, or duplicate sample);
  - Time of collection (military time);
  - Number of samples;
  - Volume of containers;
  - Analysis request;
  - Preservation methods; and
  - Remarks such as sample integrity, laboratory calibration, and standards traceability documentation.

- Borehole Logs and Log of Monitoring Well Installed

  The field geologist will prepare a field borehole log for each borehole advanced during drilling activities. Information presented in the borehole logs will include the following:

- Project number;
- Borehole number/location;
- Name of geologist;
- Total depth advanced;
- Date advanced;
- Inspector's initials;
- Sample numbers;
- Geological description;
- Remarks;
- Initial Water level (if applicable); and
- Monitoring well diagram (if installed).

- General Field Procedures

  Field personnel will be responsible for following the general field procedures outlined in the **Revised SAP (Komex, 2002c)**. Any deviation from the procedures outlined in the **Revised SAP (Komex, 2002c)** will be noted in the Field Note Books and Sample Collection Records, if appropriate.

- Corrective Action Reports

  The PQAM will be responsible for reviewing all of the forms described above and generating a corrective action report for any irregularities. The report will include:

  - A definition of the error/problem;
  - Assignment of responsibility for investigating the error/problem;
  - Definition of the cause of the error/problem;
  - An outline of the appropriate corrective action to be taken;
  - Assignment and acceptance of responsibility for implementing the corrective action;
  - Establishment of measures to assess the effectiveness of the corrective action;
  - Verification of the effectiveness of the implanted corrective action.

1.7.2 QAPP UPDATES

The project manager is responsible for assuring that if any amendments or revisions to the QAPP occur, that the USEPA Project Manager is forwarded a copy of review and that following review and finalization, the final copies are sent to all individuals on the distribution list.

1.7.3 LABORATORY RECORDS

Information to be included in the data report packages provided by AES., the designated laboratory will be as follows:

- Sample Summary Results

  The Sample Summary Results will include verification that the sample met the holding times prescribed in the analytical methods; the overall number of samples; sample location; any deviation from the Standard Operating Procedures (SOPs), time of day and date. Corrective action procedures to replace samples violating the protocol also will be noted.

- Sample Management Records

  This will include records of sample receipt, handling and storage, and scheduling of analyses.

- Test Methods

  If analyses are performed exactly as prescribed in the SOPs this document will not be provided. Otherwise, the report will provide a description of how the analyses were performed in the laboratory including: sample preparation and analysis, instrument standardization, detection and reporting limits and test-specific QC criteria.

- QA/QC Reports

  Laboratory QA/QC reports will include an initial demonstration of capability; instrument calibration; routine monitoring of analytical performance; calibration verification and checks for blanks, spikes, calibration check samples, replicates, and splits.

Copies of all results and records will remain within AES's project files and within Komex's project files for a minimum period of ten years. .

1.7.4 DATA HANDLING RECORDS

The Project Data Manager (PDM) will be responsible for reviewing all of the data handling records and verifying the accuracy of data transcription and calculations.

2 MEASUREMENT/DATA ACQUISITION

2.1 SAMPLING PROCESS DESIGN

The sampling process design includes groundwater sampling of all accessible Site wells, and will include the additional groundwater monitoring wells upon installation. **Table 4** provides a list of groundwater chemical samples to be collected.

The sampling frequency of monitoring Wells MW-6, MW-6A, MW-7 and disused supply well WSW-1 was reduced to annually, as per agreement with the regulatory bodies and all concerned parties, at the cleanup progress meeting at the EPA regional office in Kansas, on April 15th, 2002. All other monitoring Wells (MW-3, MW-4, MW-5, MW-10, MW-11 and MW-11A) are to be sampled on a quarterly basis. Samples from the shallow monitoring wells will aid the evaluation of groundwater impacts at the Site.

Table 4: Samples to be Collected

Sample Type	Number of samples
Monitoring well water samples	10 (+3 additional groundwater monitoring wells upon installation)
Duplicate samples	1
Trip Blanks	1
Field Blanks	1
Equipment Blanks	1

2.2 SAMPLING METHODS REQUIREMENTS

2.2.1 SAMPLING METHODS

Laboratory calibration and analytical procedures will be conducted using the guidelines presented in USEPA (1986). A detailed description of the sampling collection methods is provided in the accompanying **Revised SAP in Sections 3.1.2, 3.2.4 (Komex, 2002c) and as Appendix A**. Sampling containers for use in the collection of soil and water samples will be provided by the contract laboratory and will be prepared in accordance with Office of Solid Waste and Emergency Response (OSWER) Directive #9240.0-05 "Specification and Guidance for Obtaining Contaminant-Free Sample Containers", and USEPA guidance documents. Sample containers will be as noted in **Table 5**. The FPM is immediately responsible for

adherence to sampling methods outlined in the QAPP and **Revised SAP (Komex, 2002c)** in the field.

Water samples will be preserved by storing samples in a cooler with ice, or an ice substitute, for shipment to the laboratory, prior to analysis. In addition, water samples for organics will be preserved by adding 1:1 hydrochloric acid (HCl). However, if acidification of the sample causes effervescence, the samples will be submitted without preservation except for cooling. This should be noted on the sample label since the holding time for an unpreserved volatile organic analysis (VOA) sample is seven days. All samples will be analyzed within the appropriate holding times. A listing of required sample containers, preservatives, and holding times is presented in **Table 5**.

Table 5: Sample Container, Preservation, and Holding Time Requirements

Sample Container and Volume	Sample Preservation	Holding Time from Collection	Laboratory Analysis
40 ml VOA with Teflon-lined lid	Cool to 4°C, HCl to pH <2	10 days	USEPA 8260B (CVOCs)
2 1-Liter Boston Round	Cool to 4°C, 0.008% $Na_2S_2O_3$	47 days (7 days to extraction, 40 days to analysis)	USEPA 8270C (SVOCs)
100 ml. Polyethylene or Glass with Teflon-lined lid	Cool to 4°C	14 days	USEPA 310.1 or 310.2 Alkalinity
100 ml. Polyethylene or Glass with Teflon-lined lid	Cool to 4°C, H_2SO_4 to pH <2	28 days	USEPA 410.2 Chemical Oxygen Demand
100 ml. Polyethylene or Glass with Teflon-lined lid	Cool to 4°C, HCl to pH <2	28 days	USEPA 415.1 or 9060 Total Organic Carbon (TOC)
100 ml. Polyethylene or Glass with Teflon-lined lid	Cool to 4°C	7 days	USEPA 160.1 Total Dissolved Solids (TDS)
500 ml. Polyethylene or Glass with Teflon-lined lid	Cool to 4°C	7 days	USEPA 160.2 Total Suspended Solids (TSS)
100 ml polyethylene	Cool to 4°C	28 days	USEPA 120.1 Specific Conductance
1000 ml. Polyethylene or Glass with Teflon-lined lid	Cool to 4°C	48 hours	USEPA 405.1 Biochemical Oxygen Demand (BOD)
100 ml. Polyethylene or Glass with Teflon-lined lid	H_2SO_4 to pH <2	6 months	USEPA 130.2 (Hardness)
250 ml High Density Polyethylene	Cool to 4°C	48 hours	USEPA 300.0 (Cations)
500 ml High Density Polyethylene	pH<2 HNO_3	6 months	USEPA 207.1 (Anions)
Sterile 100 ml Polyethylene	Cool to 4°C	6 hours	SM 9221B (Total Coliform) SM 9221C (Fecal Coliform) Biological Enumerations
8 oz clear wide mouth	Cool to 4°C	47 days (7 days to extraction, 40 days to analysis)	USEPA 8082 Polychlorinated Biphenyls (PCBs) Sediment Sample
1000 ml amber glass bottle with Teflon-lined lid	Cool to 4°C, pH 5-9	47 days (7 days to extraction, 40 days to analysis)	USEPA 8082 Polychlorinated Biphenyls (PCBs) In Water

2.2.2 EQUIPMENT NEEDED AND DECONTAMINATION

Sampling equipment to be used in groundwater sampling is outlined under **Task 1.2, Section 4.1.2 of the accompanying Revised Work Plan (Komex 2002a)**. Equipment to be used in advancement of boreholes, collection of soil samples and the installation of groundwater monitoring wells is outlined under **Task 3, Sections 4.3.1 and 4.3.3 of the Revised Work Plan (Komex 2002a).**

All equipment likely to come into contact with sample matrix during sampling will be decontaminated before sampling begins and between each sample. Equipment will be rinsed first with isopropanol and then nitric acid to COC. After a final rinse with de-ionized water, the equipment will be wrapped in aluminum foil to keep clean during storage. Drilling equipment, including augers, stem and bits will be decontaminated by use of a steam cleaner, before initial use and between boreholes, to prevent cross contamination between boreholes.

Decontamination will be carried out in an area where drainage from decontamination activities will be contained. The FPM is immediately responsible for proper onsite equipment needs and decontamination.

2.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Custody procedures are used to document the identification and possession of each field sample from the moment it is sampled through its final disposition. This may include being introduced as evidence in litigation. Field COCFs document the collection of the sample (e.g. date and time of collection, field location, sample labeling, analyses required) and track it from the field through transfer to the laboratory. Laboratory internal custody procedures document the tracking of samples throughout the preparation, analysis, storage or disposal of samples and extracts.

2.3.1 SAMPLE PACKAGING

The collected water samples will be sealed, labeled, and packed on ice in a portable cooler immediately after collection. A trip blank will be included with each batch of samples sent to the laboratory. Sample containers will be packed in zip locked bags in order to minimize contact between ice and sample container, reducing the likelihood of cross contamination. Inert, soft packaging (e.g. bubble wrap) will be used to minimize the likelihood of impact damage during transit. Once packed, a custody seal will be placed across the lid of the sample

cooler. The cooler will be delivered to the laboratory, within the holding time of analyte(s) to be measured, whereupon the integrity of the custody seal will be checked.

2.3.2 FIELD SAMPLE CUSTODY PROCEDURES

The FPM is responsible for the implementation and maintenance of sample custody procedures in the field. The COCF (see **Revised SAP, Komex, 2002c**) will be initiated by the sampling personnel as a result of the completion and attachment of sample labels to the sample containers and by the transcription of supporting information into the field notebooks. COCF documentation will be prepared after the samples have been collected. The FPM will control the samples in a manner that minimizes the likelihood of sample tampering and degradation, contamination, or loss due to chemical or physical actions (e.g., photodegradation, breakage, volatilization). Physical control over collected samples may be maintained by:

- Storing samples and sample containers within the FPM's immediate possession;
- Storing the samples and sample containers in a locked and restricted room; and
- Sealing and storing the samples and sample containers in a way that guarantees the evidence of entry is obvious once the containers are opened (e.g., custody seals).

Transfer of sample custody from the FPM, or designate, to the laboratory will be accomplished using the field COCF. One COCF must accompany each container in which the samples are packed. Each form will be prepared with information describing samples contained in the packing container, including: sample code, sampling date and time, preservation methodology, analyses requested and shipping company/airbill number. Once the accuracy of the information on the form has been confirmed, the form will be signed by the FPM or designee and the original will be placed in a plastic bag inside the packing container. One of the copies will be retained by the field team and placed in the project file.

2.3.3 SAMPLE LABELING

Sample labels are necessary to ensure proper sample identification. The labels should also be sufficiently durable to remain fixed to the sample container and legible even when wet. The following information will be specified on each label:

- Project name and number;
- Sample location;
- Sample identification number (which include sample matrix, date, and a location related identifier);

- Date and time of collection;
- Preservatives used (if applicable);
- Laboratory analyses requested (if known); and
- Initials of collector.

2.3.4 LABORATORY CUSTODY PROCEDURES

The sample custodian at AES will sign the field COCF and will indicate on each form the date of arrival, the number of samples received, condition of the cooler custody seal and condition of samples upon receipt. The samples will be entered into the laboratory's sample custody system, which will continue tracking the sample until a data package is generated and delivered to the PQAM for this project.

2.4 ANALYTICAL METHODS REQUIREMENTS

Field analytical methods are outlined in the Field Operating Procedures (**Appendix A of the accompanying Revised SAP, Komex, 2002c**), chemical analytical methods are specifically outlined in the AES QAPP attached as **Appendix A** of this QAPP. The AES Laboratory Manager is responsible for corrective actions related to chemical analysis at the laboratory, standard laboratory turnaround times sufficient for the time requirements of this project.

2.5 QUALITY CONTROL REQUIREMENTS

Quality control samples related to both field and laboratory operations are used as measures to assess accuracy, precision, and representativeness. The internal QC samples to be used during this project include blank samples, duplicate samples, and spiked samples. Each type of QC sample is described below, including the rate of collection, and the number of field QA/QC samples specifically for this project are outlined in **Table 4.**

2.5.1 BLANK SAMPLES

The results from the analysis of blank samples are used to assess possible levels of COC introduced into the samples during container manufacture, container handling in the field, during shipment, or in the laboratory.

2.5.1.1 Equipment Blanks

An equipment blank is prepared by exposing sampling materials (e.g., bottles, collection devices) to the sampling environment without allowing them to actively mix with the matrix of

interest. Equipment blanks will be collected after standard decontamination of the field equipment by fully rinsing the equipment, which would normally contact the sample with deionized water. Equipment used in the homogenization of field duplicates (e.g., stainless steel bowl, trowel) should also be rinsed with deionized water. The analyses performed on equipment blanks is specified in the **Revised Work Plan (Komex 2002a)**. Results obtained from analysis of equipment blanks are used to assess the potential contamination from sampling equipment used to collect and transfer samples and ambient Site conditions. Potential sources of contamination also include: laboratory reagents, sample containers, laboratory glassware cleaning procedures, or contact with analytical glassware/hardware during laboratory sample preparation and analysis.

2.5.1.2 Field Blanks

Field blanks are aliquots of the water used to collect the equipment blanks but are not exposed to the equipment. If an equipment blank shows contamination, the results of the field blank analysis are used to isolate the cause of the contamination. This is critical for organics analysis, because some sources of "clean" water actually contain trace levels of contamination. Ideally, a field blank should be collected each time an equipment blank is collected. At a minimum, a field blank will be taken when the first equipment blank is collected or when a new source of water is used.

2.5.1.3 Laboratory Blanks

Laboratory blanks are prepared on each day that samples are extracted or one per 20 field samples, if more than 20 samples are extracted in one day. Laboratory blanks are indicative of contamination that is solely laboratory related.

2.5.1.4 Trip Blanks

A trip blank is a sample bottle prepared in the laboratory containing deionized, distilled water, with organics removed by carbon adsorption, and HCl added as a preservative. The trip blank accompanies unused sample bottles to the field and is then returned to the laboratory. Trip blanks are handled, transported, and analyzed in the same manner as the field samples, except that trip blank sample bottles are not opened in the field. The results obtained from analysis of trip blanks are used to assess potential sources of contamination in the laboratory and during transport. Potential sources of contamination include: laboratory reagents, sample container and laboratory glassware cleaning procedures, cross contamination during shipment, ambient

air, or contact with analytical glassware/hardware during laboratory sample preparation and analysis.

2.5.2 DUPLICATE SAMPLES

Duplicate samples are defined as separate samples taken from the same location at the same point in time. The analytical results obtained from these samples are used to assess and document the precision of sampling and analysis. The types of duplicate samples are described below.

2.5.2.1 Field Duplicates

The frequency of field duplicates is one per 20 samples collected per sample matrix. Soil and sediment duplicates are actually co-located samples; samples taken as close to the same depth interval and proximity as possible. Field duplicates are handled, transported, and analyzed in the same manner as the other samples collected on the same day. Field duplicate testing will also be undertaken for pH, conductivity, temperature, and other field measurements. The results obtained from analyzing field duplicates are used to assess and document the reproducibility of overall sampling, handling, and analytical procedures. Duplicate samples taken in the field represent the heterogeneity of field conditions. Therefore, it is expected that precision estimates obtained from the analysis of field duplicate samples will have a degree of associated variability, more so than replicate samples prepared in the laboratory.

2.5.2.2 Laboratory Duplicates

Laboratory duplicate samples are defined as two sample aliquots taken from the same sample container and analyzed independently. Samples will be prepared and analyzed for each type of organic analysis at a frequency of one per 20 samples. The analysis of samples will show laboratory precision for the spiked analytes and other unspiked positive results.

2.5.3 SPIKED SAMPLES

Spiked samples are prepared in the laboratory to define the accuracy of the analytical procedure. Laboratory control samples are prepared to demonstrate that the method is in control; matrix spike samples show the effect of the individual sample matrix on analyte recovery. In addition, surrogate analytes are spiked into all field samples to demonstrate analytical accuracy on a sample-specific basis.

2.5.3.1 Laboratory Control Samples

A laboratory control sample (LCS) and a duplicate LCS are prepared by spiking two aliquots of a blank matrix with the target analytes for each method. Alternatively, a certified Standard Reference Material (SRM) is extracted and analyzed as a control sample. A LCS and a duplicate LCS are prepared on every day of sample preparation or for every batch of 20 field samples prepared (whichever is more frequent). The percent recovery and the percent difference are calculated by dividing the concentration found by the concentration spiked and multiplying by 100. QC criteria are specified in each method.

2.5.3.2 Matrix Spike/Matrix Spike Duplicate Samples

Matrix spike/matrix spike duplicate samples are prepared in the laboratory by spiking two aliquots of a field sample with target analytes (or a subset of target analytes). The frequency of matrix spike/matrix spike duplicate sample preparation is one per 20. Percent recovery is calculated in the same manner described above for laboratory control samples. Matrix spike/matrix spike duplicate samples provide information on the accuracy of the method for the specific sample matrix. They also provide precision data for both the spike analytes and unspiked positive results.

2.5.3.3 Surrogates

Surrogate compounds are structurally similar to the analytes of interest in the organic method but are not typically found as contaminants in the environment. They are frequently isotopically labeled, such as deuterated organics. Percent recovery is calculated in the same manner described above for laboratory control samples. QC requirements are specified in each method.

2.5.4 STANDARDS

Field instrument standards will be calibrated using the appropriate standards for the instrument. The standards used may include:

- pH-buffers traceable to National Institute of Standards and Technology (NIST);
- Conductivity - Potassium chloride (KCl) solutions; and
- Temperature - NIST certified thermometer.

Primary reference materials and purchased standards must be certified and/or have a certificate of analysis. The laboratories will follow the procedure specifications for preparation

of solutions and document their preparation. This information must be available to the PQAM, should the need arise.

2.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE REQUIREMENTS

Instruments and equipment to be used at the Site by Komex will be calibrated prior to use, or will be within manufacturer stated calibration periods. Such equipment includes: compass for measuring strike/dip, water parameter meters, and organic vapor analyzers for head space analysis and health and safety monitoring. Due to the short duration of work, preventative and corrective maintenance falls outside of the period of time work will be performed. For this reason two water parameter meters and organic vapor analyzers will be taken onsite, as these are crucial to sampling methodology and health and safety, which will allow a replacement to be used upon failure.

A CME 75 hollow stem auger drilling rig will be used to advance boreholes and install additional groundwater monitoring wells on the site. This will be supplied and operated by Phillips Services Corporation, Illinois, a Missouri-licensed drilling contractor. Komex will oversee and direct drilling operations in accordance with the current **Revised Work Plan (Komex, 2002b), Revised SAP (Komex, 2002c) and Revised HASP (Komex, 2002).**

2.7 INSTRUMENT CALIBRATION AND FREQUENCY

To assure that data are representative of the actual field conditions, field equipment, will, as required, be routinely calibrated. The calibration procedures will be in accordance with the specific manufacturer instructions and the frequency for field equipment calibration are as follows:

- Compass; checked by manufacturer;
- Water parameter meter; calibrated twice daily with: three pH standards; a conductivity standard which will be based on expected conductivity; a turbidity standard; atmospheric oxygen content; and
- Organic vapor analyzer; calibrated twice daily to hexane or isobutylene, or calibrated as needed if large variability in samples is encountered.

Equipment calibration forms are to be used in conjunction with information supplied by the manufacturer. For each calibration, the time and date of the procedure, equipment

identification number, calibration procedure used, and type of standards used will be recorded on field forms and/or notebooks attached to the equipment.

2.8 INSPECTION/ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES

To assure that data are representative of the measurements and field conditions, all supplies and consumables will be inspected and their conditions noted on the Record of Consumables and Inspection/Testing Requirements. Consumables that may affect measurements include sample bottles, materials for decontamination activities, deionized water, and potable water.

Upon receipt of consumables or supplies, the FPM will inspect the supplies and fill out a Log for Tracking Supplies and Consumables. The log includes the inspection/acceptance requirements for consumables and a record for consumption. Damaged or corrupted consumables/supplies will not be accepted for use at the Site. Sample vials that may be cracked, have been stored improperly, or have visible evidence of tampering are not acceptable supplies.

2.9 DATA ACQUISITION FROM NON-DIRECT MEASUREMENTS

It is likely that Komex will collect, review and evaluate work plans, remedial action plans, quarterly reports, investigation reports, permits (e.g. well, encroachment, remediation system, etc.), correspondence and other documentation prepared by others as part of the investigation described in the accompanying **Revised Work Plan (Komex 2002a)**. QA/QC data for each document will be reviewed and noted. The representativeness, bias, precision, and qualifiers for the data will be reviewed. Items without sufficient QA/QC controls may be evaluated, but any interpretations made using data without sufficient QA/QC controls will be qualified in any final report prepared by Komex.

2.10 DATA MANAGEMENT

2.10.1 DATA REDUCTION

The calculation of final results from raw data varies according to parameter and calibration approach. Laboratory data are generated following equations specified in each analytical method. In general, the ratio of instrument response for each analyte of interest to analyte concentration is defined for one or more calibration standards. If the calibration is linear, the average of the ratios is used as an average response factor to calculate sample response. If

calibration is not linear, a calibration curve is made by plotting the concentration at a minimum of three concentration levels versus the instrument response, and sample concentration is calculated using a linear regression equation. Raw data are adjusted to account for the original sample size, dilutions, and wet or dry weight (for soil samples only) to produce a comparable concentration. These data and associated quality control data (e.g. blanks, spikes, duplicates) are provided by the laboratory in a data package. Also included in the data package will be copies of pertinent notebook pages, sample preparation information, raw data and signed COCF.

2.10.2 DATA VALIDATION

Each data package will be reviewed to confirm that analytical data quality objectives have been met. It is not anticipated that raw data will be assessed in the review of the data packages. The areas listed below will be reviewed (where applicable) to verify the usability of the data:

- Holding Time
- Data Package Completeness
- Instrument Calibration
- Blank Data
- Chromatogram/Mass Spectrometer (GC/MS) Tuning
- Surrogate Recoveries
- Field Duplicates
- Matrix Spike/Matrix Spike Duplicate Data
- Spike Recoveries
- Narrative

For accuracy, the surrogate recoveries will be examined, where applicable, and the matrix spike/matrix spike duplicates spike recoveries will also be checked against the specified QC criteria for their respective methods. In addition to the aforementioned recovery information, a check for contaminants will be performed for the following QC samples:

- Field Blanks;
- Equipment Blanks;
- Laboratory Blanks; and
- Trip Blanks.

For precision, an analysis of the following QC samples will be performed:

- Matrix Spikes/Matrix Spike Duplicates;
- Field Duplicates; and
- Laboratory Duplicates.

2.10.3 DATA REPORTING

Chemical data will be generated by the laboratories and submitted to Komex as hard copy data packages. As necessary, data will be qualified as a result of data validation. QA procedures will be implemented to ensure that errors do not occur during data transfer. After data are entered into spreadsheets or databases, it will be checked by the computer operator and the PQAM will check the printouts against the original laboratory sheets.

3 ASSESSMENT/OVERSIGHT

3.1 ASSESSMENTS AND RESPONSE ACTIONS

The performance and capability of the project will be accomplished through internal and external performance audits.

3.1.1 ASSESSMENTS

3.1.1.1 System Audits

A quality review board (QRB) will be established for the sampling and data acquisition program. The function of the QRB is to assure that the client receives a quality product and that applicable professional standards and regulatory requirements are met. The QRB is responsible for reviewing and approving the Work Plan, which includes the SAP, QAPP and any amendments to these documents. The QRB is also responsible for reviewing all major documents produced as part of this study. In addition, the PQAM will audit the overall QA/QC system for the sample collection, storage, and transfer of field samples within a few days of the beginning of the project. The purpose of the system audit is to measure the capability of the project's overall sampling and analysis system to generate data of the required quality and to evaluate the degree to which the QA/QC system has been complying with the QAPP and any of the amendments to the QAPP.

Additional QA/QC reviews will be performed by an independent third party upon completion of the project if required.

3.1.1.2 Performance Audits

Informal performance audits of the field operations will be conducted by the PM or FPM and the PQAM to assess the field sampling performance by reviewing the field logbooks and COCFs on a periodic basis. Laboratory performance will be monitored by the PQAM and PCTM as part of the data quality review process. Frequent communication by PQAM, PCTM, and the subcontracted laboratory will be maintained throughout the program. It is not anticipated that a physical audit of the laboratory will be conducted.

3.1.2 CORRECTIVE ACTIONS

A system for reporting, evaluating, and resolving nonconformance with established quality standards is a significant component of any QA plan. Need for corrective action is triggered by an identified or potential deficiency in an activity, data set, or document that may adversely affect program objectives. Corrective actions, either short-term or long-term, are instituted to eliminate the cause of nonconformance. Where corrective actions are needed, the following Closed-Loop Corrective Action system is used:

- The problem is defined;
- Responsibility for investigating the problem is assigned;
- The cause of the problem is defined;
- The appropriate corrective action is outlined;
- Responsibility for implementing the corrective action is assigned and accepted;
- Measures to assess the effectiveness of the corrective action are established;
- The corrective action is implemented; and
- The effectiveness of the corrective action is verified.

Corrective action needs are defined on a continual basis through vigilance on the part of the entire project team, and on a periodic basis through Komex's and the project's system of QA audits and reviews. Equipment and instrument malfunctions can frequently be repaired immediately on site. Corrective actions such as these should be recorded in the field notebook and further documentation is not necessary. If the problem cannot be remedied in this manner, the project team member is expected to identify the concern and notify the PM and PQAM in writing. The PM or PQAM then initiates the involvement of responsible staff to resolve the issue.

The time required for appropriate corrective action may be as short as an on-the-spot remedy, or as long as several weeks. In the later case, Komex's PM consults with the client to evaluate whether sampling and/or analysis should continue or be put on hold pending accomplishment of the corrective action.

The PQAM reviews corrective action reports, evaluates corrective actions, and reviews and files each corrective action report into the project's QA files. The PM and PQAM are responsible for reviewing the results of major corrective actions to evaluate and document the effectiveness of the actions in the corrective action forms and follow-up memoranda. These memoranda are maintained in the filing system established for all of the project's QA records.

3.2 QA/QC REPORTING TO MANAGEMENT

The PQAM is responsible for providing the PM with QA/QC reports. These reports will be generated after reviewing the data from the laboratory or as proscribed by the PM. They will contain a periodic assessment of data accuracy, precision, and completeness, and any contamination problems in blank samples. If there are any significant QA problems, they will be documented in the QA/QC reports along with recommended solutions. A summary of the status of analytical data will also be given.

4 DATA VALIDATION AND USEABILITY

4.1 DATA REVIEW, VALIDATION, AND VERIFICATION

The accuracy, precision, and completeness of the environmental data collected as part of this project will be routinely assessed for each measurement parameter. The following section describes the procedures to make data accuracy, precision, and completeness assessments, and the methods used to obtain the information for the precision and accuracy calculations.

4.1.1 ACCURACY ASSESSMENTS

Accuracy, or bias, of the data will be assessed through the use of the matrix spike/matrix spike duplicates, laboratory check standards, and spike surrogate recoveries.

Matrix spike and matrix spike duplicate spike percent recoveries are calculated as follows:

$$\text{Matrix Spike \% Recovery} = \frac{SSR - SR}{SA} \times 100$$

Where:

SSR is Spiked sample result;
SR is Sample result; and
SA is Spiked analyte added.

Spike surrogate recoveries and performance evaluation sample recoveries are calculated using the following equation:

$$\text{\% Recovery} = \frac{\text{Concentration (or amount) found}}{\text{Concentration (or amount) spiked}} \times 100$$

The percent bias is calculated by subtracting 100 % from the percent recovery.

4.1.2 PRECISION ASSESSMENTS

Data precision estimates can be defined via field duplicate and laboratory duplicate samples. Field duplicate samples provide a precision estimate for the overall measurement system, which includes the following elements: Sample acquisition, homogeneity, handling, shipping, storage, preparation, and analysis. Laboratory duplicates provide a means to assess the analytical precision based only on sample preparation and analysis.

Precision is usually expressed as relative percent difference (RPD). For matrix spike and matrix spike duplicates, RPD is calculated as follows:

$$RPD = \frac{MSR - MSDR}{(0.5)(MSR + MSDR)} x100$$

Where, MSR = Matrix spike recovery; and MSDR = Matrix spike duplicate recovery.

Similarly, laboratory duplicate and field duplicate RPDs can be calculated by substituting the sample concentration and its corresponding duplicate concentration for MSR and MSDR, respectively, into the previous equation:

$$RPD = \frac{Conc_{sample} - Conc_{duplicate}}{(0.5)(Conc_{sample} + Conc_{duplicate})} x100$$

Where, $Conc_{sample}$ = concentration of sample and $Conc_{duplicate}$ = concentration of duplicate.

4.2 VALIDATION AND VERIFICATION METHODS

4.2.1 FIELD DATA VALIDATION

Field data calculation, transfers, and interpretations will be performed by the field personnel and reviewed for accuracy by the PQAM and PM. The PQAM will recalculate at least 5% of all data reductions. All logs and documents will be checked for:

- General completeness;
- Readability;
- Usage of appropriate procedures;
- Appropriate instrument calibration and maintenance;
- Reasonableness in comparison to present and past data collected;
- Correct sample location; and
- Correct calculations and interpretations.

4.2.2 LABORATORY DATA VALIDATION

A Laboratory Quality Management Plan (LQMP) for the contract laboratory selected is included as **Appendix A**. The LQMP, or SOP for the QC Program includes a discussion of the laboratory's operating and review procedures. Ten percent of all analytical data, as determined by the PQAM, must be validated by an individual who is independent of the analytical laboratory. Data validation procedures will be consistent with those described in the USEPA Guidance for Data Quality Assessment, 1998.

4.3 RECONCILIATION WITH USER REQUIREMENTS

The QRB will review all major documents produced as part of this study. The QRB will evaluate whether the data quality objectives of the project were met and how to correct any deficiencies in the data quality through the QA/QC audit.

5 REFERENCES

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Komex, 2002b. Revised Work Plan, Missouri Electric Works (MEW) Site, Cape Girardeau, Missouri. Dated August.

Komex, 2002c. Revised Sampling and Analysis Plan, Missouri Electric Works (MEW) Site, Cape Girardeau, Missouri. Dated August.

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USEPA, 1998. Guidance for Data Quality Assessment: Practical Methods for Data Analysis (QA/G-9), EPA/600/R-96/084, Office of Research and Development.

FIGURE 1: SITE ORGANIZATIONAL STRUCTURE AND RESPONSIBILITIES CHART

USEPA PROJECT MANAGER AND RQAM

- PM: Overall responsible for investigation from regulatory standpoint
- PM/RQAM: Reviewing and approving QAPP
- PM: Reviewing and approving SAP, Work Plan and HaSP
- PM: Reviewing reports and schedule adherence

Project Manager
Paul E. Hardisty, Ph. D.

- Overall design and implementation of the project including development of the work plan
- Assuring that the specific field methods and analytical methods included in the Sampling and Analysis Plan (SAP) are appropriate to provide data for the intended use;
- Overall responsibility for the implementation of QA/QC measures included in this QAPP
- Overall performance and compliance with applicable regulations and procedural guidelines as specified in this HaSP.

Project Quality Assurance Manager (PQAM)
Robert L. Traylor, R.G., C.Hg.

- Project quality assurance;
- Review of all reports, work plans, and laboratory data;
- Evaluating deviations from SAP or work plans.

Project Consistency Reviewer (PCR)
James Clark, Ph. D.

- Assist PQAM with laboratory data validation
- Validate electronic and hard copy data consistency

Project Chemistry Task Manager (PCTM)
Thomas Browne , Ph. D.

- Review of work plans, SAP, QAPP, and all amendments to assure field and analytical chemistry methods are appropriate

Field Project Manager (FPM)
Shawn Roberts, Ph.D.

- Coordination and supervision of technical field activities at the site
- Controlling access to site
- Execution of work plan;
- Documenting all work progress
- Maintenance of all records

Project Field Team Members (PFT)
Tony Jones, Ph.D., Ian Jones, Ph.D.

- Reviewing and understanding all work plans, QAPP, SAP HaSP, and all amendments.)

Analytical Environmental Services, Inc.
Laboratory Manager

- In charge of all Laboratory Processes
- Chemical QA/QC and reporting.

Corporate Health and Safety Officer
James Clark, Ph. D.

- Establishing all corporate health and safety procedures for Komex;
- Ensuring that the company is in compliance with all Federal, State and Local guidelines regarding health and safety issues;
- Confirming that all employees have appropriate health and safety training and have taken a current respirator fit test as outlined in the Komex Respiratory Protection Program (RPP);
- Verifying that all employees are current in the Komex Medical Surveillance Program (MSP);
- Maintaining records regarding employee safety training, respirator fit testing and medical screening; and
- Reporting all accidents to the necessary authorities

Project Health and Safety Officer
James Clark, Ph.D.

- Preparation, implementation and updating of the site specific Health and Safety Plan (HaSP).

Site Health and Safety Officer
Shawn Roberts, Ph.D.

- Daily assessments of health and safety practices at the site(s)
- Evaluation of site conditions.
- Assisting PM with on site implementation of this HaSP
- Maintaining safety equipment supplies
- Performing air monitoring of the breathing zones of workers (if deemed necessary).
- Setting up work zone markers and signs
- Conduct daily safety meetings involving all persons permitted to enter the contaminated area (Exclusion Zone)

AES, Inc.
3781 Presidential Pkwy., Suite 111
Atlanta, GA 30340

STANDARD OPERATING PROCEDURES FOR THE QUALITY CONTROL PROGRAM

TABLE OF CONTENTS

STANDARD OPERATING PROCEDURES FOR THE QUALITY CONTROL PROGRAM

1.0 INTRODUCTION

1.1 Background

Analytical Environmental Services, Inc. (AES) is located at 3781 Presidential Parkway, Suite 111, Atlanta, Georgia 30340. The principal activities of AES are to provide a broad range of analytical laboratory services for organic and inorganic constituents in a variety of sample matrices.

1.2 Quality Policy

The objective of AES Inc. is to generate high quality data which is accurate, reliable and adequate for its intended use, with absolute impartiality, in a cost-effective manner. Accordingly, AES' management is committed to promoting excellence in analytical testing and providing the necessary resources, along with an environment conducive to its achievement.

1.3 Purpose

The Quality Assurance Program (QAP) sets forth the management policy, organizational structure and procedures for chemical analyses performed by AES. Due to the diversity of services provided by AES, it is not possible to set forth all-inclusive statements or to establish a rigid closed quality system. AES' management encourages the development and use of the best testing practices as dictated by each analytical situation. However, the procedures set forth herein must be followed to the greatest extent possible. All deviations must be documented in each individual case and maintained with the sample data.

Appropriate use of data generated under the varying conditions encountered in environmental analyses requires reliance on the quality control practices incorporated into the procedures. Although the EPA, State EPDs, other regulatory agencies, and clients require the use of approved methods for sampling and analysis, the mere approval of these procedures does not guarantees adequate results. Inaccuracies can result from many causes including matrix effects, equipment malfunctions and operator error. Therefore, the quality control component of each method is indispensable and cannot be compromised.

Quality Assurance (QA) comprises all those planned and systematic actions necessary to provide adequate confidence that all aspects of laboratory service programs are performed in a manner satisfactory to AES' management and to the needs of it's customers.

Quality Control (QC) encompasses the operational procedures, techniques and activities which provide a means to measure, evaluate and document the quality of data obtained in the laboratory. The QC Program specifies the minimum practices which shall be implemented to assure that data is produced of a known and defensible quality and within acceptable limits.

This procedure will outline the elements of the QA/QC Program that must be implemented by all analytical sections of the laboratory. The requirements outlined in this procedure are the minimum requirements. Method specific procedures and project specific Quality Assurance Project Plans (QAPP) may require more stringent QA requirements. This procedure applies to all analytical sections of the laboratory.

2.0 ORGANIZATION

2.1 General

The establishment of a quality control program requires the services of all the employees of AES to carry out the monitoring, record keeping, statistical techniques and other functions required by this system. This total commitment of all personnel to the production and reporting of reliable data is dependent upon the conscientious effort of everyone involved. Therefore, it is important that each member of the organization have a clear understanding of his or her duties, responsibilities, and their relationship to the total effort.

It is recognized that the quality assurance program is an inherent function involving all of the organizational components and personnel. The achievement of quality objectives is attained by each individual performing assigned work in strict compliance with approved applicable requirements and procedures.

2.2 Organizational Structures

The organizational structure of AES provides for an independent Quality Assurance Department with overall responsibility for developing a comprehensive Quality Assurance Program and auditing for compliance to that Quality Assurance Program. The QA Department has the authority and organizational freedom to ensure that QA activities are implemented and accomplished. The Quality Assurance Manager reports directly to the President of AES.

Because of the breadth of knowledge required to produce quality data, the cooperation of numerous individuals is required. All assigned personnel shall remain diligent to identify, report, and promptly rectify issues or events affecting data quality as they occur. To encourage the identification of these situations, management at all levels shall promote continuous quality improvement throughout the entire company. These

events and their resolution must be documented as required by this document and any other applicable QA documents.

The organizational structure at AES is documented in the form of an organizational chart, which identifies the personnel involved in the production of quality data and depicts the lines of communication throughout the entire organization.

3.0 RESPONSIBILITIES

It is the responsibility of all AES employees to implement the Quality Assurance Program in a manner that assures the program's effectiveness. All chemists are responsible for understanding and following the measures of the QC program, and for reporting any quality failures to their Manager or Supervisor in a timely manner. Supervisors and Managers are responsible for ensuring that all laboratory personnel are familiar with the requirements of the Quality Control Program and that these requirements are implemented and maintained. It is the responsibility of the Supervisor to ensure that all laboratory personnel are trained to perform their assigned analyses. It is the responsibility of each Supervisor to ensure that any quality failures are reported to the Quality Assurance Department immediately.

The key personnel involved in the implementation of and/or the monitoring of the Quality Assurance Program are identified below:

3.1 President

The President is ultimately responsible for the quality of services provided by AES. The President has the authority to enforce and implement the procedures, policies and findings of the QA program. The President is responsible for the commitment of delivering the appropriate tools and resources to the senior level staff and laboratory management to ensure that the overall QA program and clients needs can be met.

3.2 Laboratory Director

The laboratory director is responsible for the overall daily operations of the laboratory. The laboratory director is to ensure that all procedures and policies are available to each staff member and that all of the resources are available to implement and follow the procedures and policies as written. The laboratory director is also responsible for ensuring that all projects are delivered to each client within the guidelines set forth in the policies and procedures of AES.

3.3 Laboratory Manager

The laboratory manager is responsible for the daily operations within the analytical sections of the laboratory. The laboratory manager is to assist in the development and enforcement of the policies and procedures of the QA program. The laboratory manager is to ensure that the laboratory is adequately staffed with technically qualified

individuals and that each member receives the proper training and resources to adhere to the QA program.

3.4 Project Manager

The project manager is responsible for directly ensuring that the individual clients needs are met on a project by project basis with respect to the laboratories QA program and any project specific QA program. The project manager is responsible for disseminating any project specific information to the laboratory manager and possibly the laboratory director. Non- routine QA requirements are to be approved by the laboratory director and laboratory manager.

3.5 QA Manager

The QA Manager has the responsibility of establishing a Quality Assurance Program that meets the quality assurance objectives of the company and its clients. The QA Manager has "stop work" authority where significant conditions adverse to quality exist. In case of emergency or imminent danger, stop work authority is immediate. The QA Manager will ensure compliance with the Quality Assurance Program, facilitate improvements and problem resolution, and enlist the support of all groups within AES Inc. in fully implementing quality assurance systems through the company. The QA Manager reports to the Laboratory Director of AES.

3.6 Managers

The managers are responsible for, among other things, the quality of their respective area. This includes if applicable:

- preparing technical proposals with appropriate QA considerations included,
- implementing the operational requirements of the QA program,
- approving all processes and procedures used within their respective area,
- obtaining documentation supporting customer-specific variances to the QA Program or to an operational procedure.
- Ensuring data is reviewed thoroughly and properly before it is released to the customer.
- Managers are authorized to reject the results of analyses and order reworks, or reanalysis, as appropriate.

3.7 Supervisors

Supervisors report to their respective Manager on all aspects of sample processing. If a section does not have a supervisor, the Manager of that section functions as the supervisor. The Supervisor's responsibilities include, when applicable:

- Training and qualification of personnel (under their supervision) on procedures.
- Developing necessary protocols and standard operating procedures including control charts.
- Assigning internal quality control duties,
- maintaining QC within their area of responsibility,
- ensuring that personnel (under their supervision) use approved procedures,
- maintaining all instrumental QC,
- recommending and implementing new or revised QC policies as approved by the QA Manager,
- reviewing preventative maintenance and QC data,
- reviewing all data and QC results,
- reporting problems to the appropriate Manger.

4.0 QUALITY ASSURANCE PROGRAM

The Quality Assurance Program (QAP), has been developed to provide a high quality document that complies with the intent of the requirement of the regulations, standards and established guidelines. The QAP takes into account requirements for special controls, processes, test equipment and skills to attain the required quality and the need for verification of quality by inspection and test. The QAP provides for the training of personnel to required proficiency levels and for regular assessments of the QAP to assure the adequacy of resources and the effectiveness of management controls established to achieve quality.

Revisions to this QAP shall be made and controlled by the QA Manager in accordance with AES' quality assurance practices. Such revisions and updates shall be performed as needed to improve the effectiveness of this program. Control of this QA manual is accomplished following the requirements of section 6.0, "Document Control".

4.1 DEFINITIONS

4.1.1 **Analytical Batch** – A group of samples of a similar matrix (i.e. soil, water, oil, etc.) processed and analyzed together as a unit. These samples will be treated with the same reagents, of the same lot numbers, if possible, and within a specified time. A batch shall have a maximum of 20 samples.

4.1.2 **Accuracy** – The nearness of a result or the mean (average) of a set of results to the true value. Accuracy is assessed by means of reference samples; laboratory control spikes, matrix spikes, etc, and is measured in percent recovery.

4.1.3 **Blank** – An analyte-free matrix, usually reagent water, designed to monitor the introduction of contaminants. All analytes associated with the blank must have concentrations less than the reporting limit for the blank to be valid.

4.1.3.1 **Calibration Blank** – specified in some analytical procedures, is an aliquot of analyte-free matrix used to establish a zero concentration instrument response value.

4.1.3.2 **Method Blank** – as aliquot of analyte-free matrix, usually reagent water, to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is carried through the complete sample preparation and analytical procedure. The method blank is used to document any presents of contamination resulting from the analytical process. A method blank may also be referred to as a reagent blank or preparation blank, depending on the procedure.

4.1.3.3 **Field Blank** – an aliquot of analyte–free water brought to the field in sealed containers, transferred to a sample container and transported back to the laboratory with the samples to be analyzed. The field blank is used to evaluate any possible contamination introduced to the samples during the field collection process.

4.1.3.4 **Trip Blank** – an aliquot of analyte-free water which accompanies the empty containers to the field and the collected samples back to the laboratory. The trip blank is an indicator of possible sample contamination originating from site conditions and sample transportation.

4.1.3.5 **Equipment Blank** – an aliquot of analyte-free water which is opened in the field and the contents poured over or through the sample collection device, collected in a sample container, and returned to the laboratory as a sample. Equipment blanks are used to monitor the

potential for contamination that may be introduced from the field sampling equipment (also known as a rinsate blank).

4.1.4 **Calibration Check** – verification of instrument response to a known amount of one or more analytes of interest following initial calibration and periodically throughout the analytical process. Calibration check standards are made from a different source than that used for the initial calibration. This standard is also called an Independent Calibration Verification (ICV), or a control standard.

4.1.5 **Laboratory Control Sample (LCS)** – Typically prepared by spiking an aliquot of reagent water or analyte – free soil with analyte(s) of interest. The LCS is prepared and analyzed employing the same methodology as the associated samples. The LCS is used to monitor, assess and control the laboratories performance of the method employed for sample preparation and analysis.

4.1.6 **Deionized Water (DI Water)** – Reagent free water that is prepared by passage through various filters and membranes.

4.1.7 **Environmental Sample** – An environmental sample or field sample is a representative portion of any matrix (aqueous, non-aqueous, mixed waste, etc.) collected from any source for which determination of composition of contamination is requested or required. For the purpose of this procedure, environmental samples are classified as follows:

4.1.7.1 Aqueous

- Surface Water
- Groundwater
- Drinking Water – treated or untreated water designated as potable water
- Wastewater – municipal and industrial influents and effluents

4.1.7.2 Soils

- Sediment / Soil
- Sludge – municipal sludges

4.1.7.3 Non-Aqueous Liquids

- Solvents
- Oils
- Fuels

4.1.7.4 Non-Soil Solids

- Solid Waste
- Precipitative Waste
- Industrial Sludges
- Concrete
- Wood
- Paint Chips
- Ash
- Wipes

4.1.7.5 Bioassay

- Bio-solids
- Municipal Waste Treatment Sludges

4.1.7.6 Air

- Filters
- Absorbent Traps
- Activated Carbon
- Passive Monitors

4.1.8 **External Quality Control** – Those practices that monitor the quality of data from sources outside the control of the laboratory (i.e. multi-laboratory performance evaluation samples and external audits).

4.1.9 **Instrument Detection Limits (IDL)** – The minimum concentration limits of an analyte above the instrument noise level that can be detected and quantified with a high degree of confidence (>95%).

4.1.10 **Internal Quality Control** – Those practices implemented internally to monitor the quality of data and which are under the control of the laboratory (i.e. inter-laboratory performance samples, internal audits, single blind samples, etc.)

4.1.11 **Matrix Spike / Matrix Spike Duplicate (MS/MSD)** – An environmental sample to which predetermined quantities of specific analytes are added prior to sample preparation and analysis. Percent recoveries are calculated for each of the spiked analytes to assess accuracy and the effect of matrices on analyte recovery. In addition, a calculation of precision is made between the results of the MS/MSD to determine reproducibility of results. This is measured by either the Relative Percent Difference (RPD) or Percent Relative Standard Deviation (%RSD).

4.1.12 **Method Detection Limits (MDL)** – The minimum concentration of a substance that can be measured and reported, in a specific matrix, with 99% confidence that the analyte is present at a concentration greater than zero.

4.1.13 **Precision** – The agreement of a set of replicate results without assumption of any prior information as to the true results. Precision is assessed by means of duplicate sample analysis and reported as RPD or %RSD.

4.1.14 **Practical Quantitation Limit (PQL)** – The lowest analyte concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The term PQL may be interchanged with the term Reporting Limit (RL).

4.1.15 **RCRA** – Resource Conservation Recovery Act

4.1.16 **Relative Percent Difference (RPD)** – A measure of agreement between two replicate results.

4.1.17 **Standard Curve** – A curve, which plots known standard concentrations or amounts of an analyte versus the instrument response for the analyte.

4.1.18 **Surrogate** – Organic compound(s) which are similar to analytes of interest in chemical composition, extraction efficiency and chromatographic retention, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to analysis. Percent recoveries are calculated for each surrogate to assess the effectiveness of the sample preparation and analysis.

5.0 EXTERNAL QUALITY CONTROL

External Quality Control is the process of employing outside sources to monitor the quality of the data produced by the laboratory. Included in the external quality control program will be the analysis of performance evaluation samples and participation in performance evaluation audits.

5.1 Performance Evaluation Samples

Performance Evaluation Samples will be submitted to the laboratory from outside sources or second-parties at specified intervals to assess the quality of data analysis for every section (organic and inorganic). These samples will be submitted to the laboratory as blind samples containing amounts of specific constituents that are unknown to laboratory personnel. The laboratory results must be completed and reported within the required turn around time. Data covering the past two consecutive

years will be stored in an easily retrievable form for presentation to auditors or concerned parties.

In the event a performance evaluation sample result is unacceptable; an investigation as to the cause of the failure will be conducted. The findings and their corresponding corrective actions will be documented in a response to the agency, client, or other party that supplied the sample. A data package, including results and correspondence, will be kept on file.

The following lists the current groups that send performance evaluation samples:

5.1.1 ELPAT

Once a quarter, the laboratory receives a set of proficiency samples from Research Triangle Institute, for analysis of lead content. The matrices are soils, wipes, and/or paint chips. The accreditation is administered by American Industrial Hygiene Association (AIHA).

5.1.2 PAT

Once a quarter, the laboratory receives a set of proficiency samples to be analyzed for metals, asbestos fibers, and organics. Sample matrix are 37mm filters for metals, 25mm filters for asbestos and charcoal or silica tubes for organics. This program is vital to AES, Inc. certification of perform analysis of indoor air quality.

5.1.3 North Carolina Department of Environmental, Health and Natural Resources

Once a year the laboratory receives performance samples for all analyses not submitted for certification for North Carolina. These samples are critical for the continuation of certification with the state of North Carolina.

5.2 Performance Audits

In order to maintain certification in many states, to comply with commercial contracts, and satisfy many agency requirements, AES, Inc. must undergo initial and ongoing audits performed by external auditors. These audits may take the form of technical and/or evidentiary audits. Every section of the laboratory, both analytical and clerical, should be ready at all times to participate in these audits.

In the event that adverse findings, deficiencies, observations and/or recommendations are found during an audit, QA and laboratory management shall review the comments and submit a response, including corrective actions, to the audit report.

5.2.1 State Audits

State Audits are performed in accordance with each individual state's certification program. These audits are usually performed to determine the laboratory's suitability to perform environmental analyses according to the parameters dictated by that state.

5.2.2 Commercial Audits

Audits performed by commercial clients may be scheduled on a pre-award basis for a contract. Once the contract is awarded, audits may be scheduled on the request of the client or a predetermined frequency. Audits performed by commercial clients may be performed by the client as well as professional audit teams.

6.0 INTERNAL QUALITY CONTROL

The internal quality control program serves two primary functions. The first is to monitor the reliability of the data (i.e. accuracy and precision). This function is the determination of quality. The second function is the control of quality (i.e. the use of ACS grade reagents, traceable standards, etc.). The following sections outline the specific actions and procedures employed to monitor the process for producing and reporting quality data that is consistent with the Quality Control Program. Processes, such as but not limited to, verification of operator competence, recovery of known spikes, analysis of reagent blanks, calibration with traceable standards, analysis of duplicates, and maintenance of control charts must be employed and continually monitored. Additional quality assurance procedures may also be adopted by the laboratory; however, the minimum requirements are discussed below. The QA manager, under restrictions by the methodology and in conjunction with the appropriate laboratory management staff shall determine which requirements will be implemented for each section.

6.1 Training and Certification of Operation Competence

Quality Control begins with establishing basic laboratory techniques and skills. Therefore, it is imperative that an analyst receives proper training before they are permitted to perform independent laboratory analysis. Proficiency of laboratory techniques and skills must be demonstrated and documented for each analyst. Records to that effect must be kept in the employees' personnel training file.

6.2 Documentation

Regardless of which analytical procedures are used in the laboratory, the methodology shall be carefully documented. Standard Operating Procedures (SOPs) and approved methods may be periodically modified, up dated or replaced entirely due to advances in technology or changes in regulatory protocols. However, procedures that are governed by regulatory protocols, agency permitting or contractual obligation shall be used, without modification, unless the procedure has been approved by the client in writing. If a method is modified, the client shall be informed of the procedural change. Pre-approval may be required by some clients before the modification is used to generate data. Documentation of analytical procedures for generating laboratory data shall be clear, concise, adequately referenced and reflect actual steps employed by the analyst.

6.2.1 Procedures

Methodologies employed in the laboratory shall be documented by the creation of a SOP. This document will provide the analyst with the necessary information to perform the analysis. All SOPs must be created in accordance with QA document: ***QA-1001 Standard operating Procedure for Creating and Maintaining Standard Operating Procedures***. It will follow the intent of the method it is patterned after, but will provide any additional information essential to the specific instrument instructions, specific quality concerns, etc.

In the event, a SOP is not available for a specific analysis; the analyst must follow EPA, Standard Methods, NIOSH or other regulatory methodology as required. No deviations of any kind are allowed. Before a new method is acceptable for routine use, adequate performance must be demonstrated. This includes a MDL study, Precision/Accuracy study, and all related QA/QC procedures as required by the method. An ad hoc technical review committee will evaluate the merits of the new method and recommend approval or rejection based on the available data. This committee will include, at a minimum, the Lab Manager and QA Manager. If the method is approved, a Standard Operating Procedure will be created and the procedure implemented.

All analytical procedures must provide documentation such that the complete process used to produce data can be reconstructed.

All deviations from an approved analytical procedure shall be approved and documented by the Quality Assurance Manager.

All changes to an approved procedure require, at a minimum, an Interim Change Notice; however, a complete revision and re-issuance of the SOP is preferred.

6.2.2 Records of Analysis

6.2.2.1 Sample Preparation, Extraction, Distillation, and Digestion

All steps of the preparation, extraction, distillation and/or digestion of samples must be thoroughly documented. Documentation must include (if applicable, as determined by QA and Laboratory Managers):

- Standard Identification
- Dilution Factors
- Sample Identification
- Reagent Identification
- Date the analysis was performed
- Initials of the analysts performing the analysis
- Volume/weight of sample used
- Final volumes/weights
- Initial and final review signatures where required

6.2.2.2 Analysis

All steps of the analysis of samples shall be thoroughly documented with instrument run logs, and worksheets. At a minimum, these records shall include:

- Sample identification
- Dilution factors
- Date of analysis
- Instruments used
- Identification of standards used
- Analysts initials
- Initial and final review signatures where required

6.2.3 Preparation of Standards and Reagents

The preparation of all standards and reagents shall be documented. The lot numbers of all standards associated with a particular project shall be traceable either through the instrument logbook, a QC check list, a worksheet, or another approved document.

Vendor certificates of analysis will be kept on record in each department.

6.3 Detection Limit Studies

The detection limit of an analyte is defined as the smallest amount of an analyte that can be detected (for instrumentation, above the background noise) within a stated confidence limit. There are several types of detection limits that may be applicable to a given method. The Instrument Detection Limit (IDL) is the amount of analyte needed to produce an adequate response above an instrument's baseline noise. The IDL may be use to estimate a Method Detection Limit (MDL). The Practical Quantitation Limit (PQL), also called the Reporting Limit (RL) is defined as the lowest level of quantitation achievable during routine laboratory operations. Some agencies define the PQL more rigidly as 4 times the MDL. However, the PQL is highly matrix dependent.

6.3.1 Organic Analyses

Method Detection Limits (MDL) studies, required for organic methods, and shall be performed in accordance to EPA 40CFR136. Results of MDL studies shall be approved by the Section Supervisor. MDL studies must be updated annually (12 ± 2 months). The raw data for the MDL study shall be stored by the appropriate section.

6.3.2 Inorganic Analyses

Method Detection Limit studies are required, where applicable, for inorganic parameters. Method Detection Limits shall be performed annually (12 ± 2 months) according to EPA 40 CFR136 when applicable. The calculated MDL is often significantly lower than the lowest calibration standard. However, realistically the lowest calibration concentration in most of inorganic chemistry analyses shall be used to define the practical quantitation limit (reported detection limit) rather than using the calculated MDL to determine the PQL/RL.

6.4 Recovery of Known Additions (Spikes)

Recoveries of known additions of analytes are used to determine the effect of the sample matrix on the given analytical procedure. The Laboratory Control Sample (LCS) and sample Matrix Spike / Spike Duplicate (MS/MSD) are used to monitor and control the analytical process. The recovery of spiked analytes in the sample matrix gives a definitive measure of the sample preparation processes.

LCS data is used to monitor the laboratories performance in respect to sample preparation and equipment operation. It is prepared in an analyte free matrix similar to the sample, i.e. water or soil. If the LCS recoveries are within acceptable limits this is an indication that the problem lies within the sample matrix itself. Recovery limits for the LCS are established by the laboratory via control charting of each analysis.

In addition, advisory recovery limits for the MS/MSD precision limits are developed for both water and soil matrices. Sample duplicate and/or MS/MSD precision limits for each method are to be specified in the analytical procedure. Precision limits for the

MS/MSD and sample duplicate are advisory and are used to assess combined sample preparation, analytical reproducibility and matrix effect on the overall analytical process.

NOTE

When possible, all departments involved in the analysis of a project should use the same sample for the MS/MSD. Appropriate caution must be exercised to ensure sufficient sample amount is available to complete sample and MS/MSD analyses. Samples chosen for the performance of the matrix spike, matrix spike duplicate, or sample duplicate shall not be samples already designated as QC samples (i.e. field blanks, prep blanks, trip blanks, field spikes, etc.).

6.4.1 Laboratory Control Sample

The Laboratory Control Sample (LCS) consists of an analyte-free matrix that is spiked with known concentrations of compounds representative of the target analytes for which the analysis is being performed. The LCS is used to monitor, assess, and document laboratory method performance. The source of the material used for the preparation of the "in-house" spiking standard must be independent of the source used to prepare the initial calibration standards. Various EPA approved methods have control limits established within their text. However, the agency prefers that the laboratory establish their own "in-house" control limits. The control limits established in an approved method may be used on an interim basis.

When the LCS analyte recoveries, including surrogates, are within laboratory established control limits, the batch is acceptable and analysis may proceed.

When an LCS analyte recovery fails a laboratory established in-house LCS control limit, but is within the published method acceptance limit, an investigation must be performed and documented to identify the root cause for the failure. The analysis of the batch may continue; however, any identified issues requiring corrective actions must be implemented before starting subsequent batches. The data associated with this LCS may be reportable, pending the results of the investigation.

When a LCS analyte recovery fails both the laboratory established in-house LCS control limit and any published method acceptance criteria, the analysis must stop. An investigation of root causes must be initiated and documented. Required corrective actions must be implemented. The affected batch must be reprocessed in its entirety.

6.4.2 Organic Department

6.4.2.1 Laboratory Control Sample (LCS)

As a measure of the extraction efficiency under ideal conditions, a LCS shall be analyzed with every batch of samples processed as a unit. The recoveries of select target analytes and surrogates in the LCS shall be used to develop in house laboratory control limits for the accuracy of each method. The recoveries of all analytes in each LCS shall be plotted on Quality Control Charts for the determination on in-house control limits.

6.4.2.2 Surrogates

As a means of monitoring individual sample extraction efficiency, one or more surrogate compounds are added to each blank, LCS, client sample and QC sample prior to preparation. In-house surrogate recovery limits for water and soil sample matrices are developed from the pooled population of sample surrogate recoveries. Typically, one of the following actions will be required when a sample surrogate recovery is out of the established control limits.

- Re-extract and/or reanalyze the sample

- Flag the results as estimated

Clients may specify the required action to be taken for recovery failure. Client specific requirements will be conveyed to the analytical sections through project management.

AES's formal policy for the acceptance of Semivolatile mass-spec data is as follows. Data for which one acid surrogate and or one base surrogate are outside the control limits will be accepted as long as the recovery of the out of control surrogate is above 10%. Re-analysis is required to confirm the out of control event.

AES' formal policy for the acceptance of Semivolatile GC analysis is as follows. When multiple surrogates are employed, one surrogate is allowed to be outside the established control limits. Re-analysis is required to confirm the out of control event.

The failure of a surrogate recovery in the method blank or LCS will require the re-extraction and / or re-analysis of the entire batch should the above conditions not be met. The root cause of such failures must be

investigated and documented in a Non-Conformance Report (NCR). Any corrective actions identified as a result of the investigation must be implemented and documented in a Corrective Action Report (CAR) prior to reprocessing the affected sample batch.

6.4.2.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

As a measure of the effect of the sample matrix on extraction efficiency and analyte recovery, a matrix spike/matrix spike duplicate pair should be analyzed. One MS/MSD pair should be prepared and analyzed in every batch of 20 or fewer samples.

In some cases, the client may specify which sample is to be used for the MS/MSD. If not, the laboratory shall pick a representative sample at random. Advisory MS/MSD recovery limits shall be established for aqueous and soil matrices. Analytes recovered outside the control limits should be flagged due to matrix effects.

For TCLP analysis, a matrix spike should be prepared and analyzed for each waste type (e.g. oil, solid) associated with a batch of 20 or fewer samples of similar matrix. Each client should specify which sample is to be used for the matrix spike evaluation.

6.4.2.4 Tracking Internal QC Samples

In order to ensure that the adequate number of Quality Control samples are analyzed for each extraction procedure, a tracking system shall be implemented by the Organic Sample Preparation Section (OSP). This tracking system shall be specific for each individual procedure requiring QC samples.

6.4.3 Inorganic Department

6.4.3.1 Laboratory Control Sample (LCS)

As a measure of the analyte recovery under ideal conditions, a Laboratory Control Sample (LCS) shall be analyzed with every analytical batch. The recovery of analytes from the LCS shall be used to develop laboratory control limits for each method. Analyte recoveries in the LCS shall be plotted on Quality Control Charts and used to determine in-house control limits.

6.4.3.2 Sample Duplicate, Matrix Spike/Matrix Spike Duplicate

A matrix spike and matrix spike duplicate (or sample duplicate) shall be analyzed at a minimum frequency as specified in the analytical procedure. Typically, a MS/MSD (or Dup/MS) will be analyzed with each group of 20 or fewer samples processed together as a batch. Upon client request, sample specific QC will be performed.

6.5 Intra-laboratory

Each section of the laboratory may be given blind and double blind samples to analyze for requested parameters. Blind samples may be assigned in containers to be diluted, digested, and/or extracted and analyzed by the appropriate laboratory section. Double-blind samples may arrive on a pre-scheduled basis from a "client" as real samples to be analyzed by designated analytical sections for specific analytes.

6.5.1 Blind QC Samples

Blind QC samples may be used as a test of proficiency for analysts needing certification and/or qualification for performing an analysis. The Section Supervisor should obtain the QC sample from either the Quality Assurance Department of from a source independent from the source of standards for the analysis.

6.5.2 Double - Blind QC Samples

Quality Control samples may arrive from a "Client" to be analyzed for specific analytes. These samples will arrive as real samples and will not be known to anyone outside Quality Assurance and Project Management. The results of these double-blind samples will be sent to the "client" to be compared to the true value of the samples. The laboratory's performance on these samples will be compared to other laboratories in the program. These results will be mailed to the Quality Assurance Department. Results are used to identify areas needing improvement.

6.6 Analysis of Blanks

The background or blank of the reagents and solvents used in a given procedure or method of analysis must be determined. This can be done in several ways depending on the particular analysis. As a minimum, the following requirements will apply to each analytical section. Acceptance criteria for the analysis of blanks shall be outlined in the applicable procedures.

6.6.1 Method Blank

The method blank is an analyte – free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank must be carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process. For the method blank to be acceptable for use with the accompanying samples, the concentration of the blank of any analyte of interest should not be above the method detection limit of required reporting limit. If contamination is detected, one of the following conditions will apply:

The reporting limit may be raised above the level of contamination in the method blank and samples with client approval.

In some procedures, when contamination is detected in the method blank but samples results are ≥ 5% the level of the method blank, data *may be reported* with a flag indicating that low level contamination was detected in the method blank (e.g. trace metals). In all other instances, re-extract, re-digest, and/or re-analyze the method blank, samples, and QC samples when an unacceptable level of contamination is detected in the method blank.

Special cases and exceptions will exist. These should be explained in the appropriate analytical procedure. Analyst discretion is required and important. Decisions to report sample results associated with a contaminate method blank must be justified, approved, and documented.

6.6.2 Organic Analyses

6.6.2.1 Method Blank

At a minimum, one method blank must be analyzed with each batch of twenty (20) or fewer samples processed as a unit. The method blank must be matrix specific and must be processed step-by-step with the samples. In addition to the contamination criteria discussed above, the method blank surrogate recovery is monitored to assess the acceptability of the batch. One of the following conditions will apply:

The method blank surrogate recovery is within the applicable in-house sample surrogate recovery limits established for each sample matrix, therefore, batch data is reportable.

The method blank surrogate recovery is outside laboratory established sample surrogate recovery limits but within published method acceptance criteria. The method blank and associated sample data may be reported, however, an investigation must be performed and

documented to identify the root cause for failing laboratory surrogate recovery limits.

The method blank surrogate recovery fails both laboratory developed and published method limits. The batch must be reprocessed in its entirety. An investigation to identify root cause must be initiated and documented. Corrective actions, if required, must be implemented prior to reprocessing affected samples.

6.6.2.2 Instrument Blank

An instrument blank may be run after any sample that gives a response that exceeds the calibration range for the instrument to show that there is no carry-over to the next analysis. The instrument blank shall consist of high purity solvent (e.g. hexane for pesticide analysis by GC/ECD, methylene chloride for semi-volatiles analysis by GC/MS).

6.6.3 Inorganic Analyses

6.6.3.1 Preparation Blank (Method Blank)

A preparation blank must be analyzed with each analytical batch. The preparation blank must be matrix specific and must be processed step-by-step with the samples. Contamination of the blank is monitored to assess the acceptability of the batch.

6.6.3.2 Initial Calibration Blank (ICB)

Before sample analysis may begin, an ICB shall be analyzed to verify there is no carryover contamination or instrument drift.

6.6.3.3 Continuing Calibration Blank (CCB)

A CCB shall be analyzed periodically throughout the analytical sequence to confirm that there is no carry-over contamination or instrument drift. The frequency of CCB analyses is specified in the analytical procedure.

6.7 Calibration of Instruments

Analytical instruments shall be calibrated in accordance with the proper analytical procedure to determine the analyte(s) of interest. After initial calibration of an instrument, a continuing calibration standard must be analyzed at specific intervals. The continuing calibration standard must meet the specified QC requirements to allow sample analysis to continue.

When reporting data, the highest reported value shall not exceed the concentration of the highest calibration standard. The lowest reported value shall be greater than or equal to 10 times the MDL. The concentration of the lowest calibration standard may be used as the reported detection limit. Exceptions to these general requirements exist. Refer to each specific analytical procedure for calibration and data reporting requirements.

The calibration checks shall be prepared from a different source than that used to prepare the calibration standards. Only in the event that a different source is not available, a different lot from the supplier may be used.

6.7.1 Organic Analyses

Calibration standards shall be of a known quality from a reliable source and shall be traceable.

6.7.1.1 Initial Calibration

Initial calibration of the instrument should begin with multi-level concentration of the analytes of interest per the applicable procedure. The instrument should be at optimum operating condition before the analysis of standards begins. The initial calibration should be evaluated before beginning sample analysis.

6.7.1.2 Continuing Calibration

Continuing calibration standards shall be analyzed according to the specific procedure. If the procedure criteria are not met, the instrument shall be recalibrated and any samples analyzed after the failed standard must be re-analyzed.

6.7.2 Inorganic Analyses (Trace Metals)

6.7.2.1 Initial Calibration

The calibration of instruments shall follow the specific procedure steps for the analyte of interest. Sample analysis shall begin only after QC requirements have been met.

6.7.2.2 Continuing Calibration

As part of all analytical sequences, continuing calibration standards must be analyzed at procedure specified frequencies. The QC criteria for these standards must meet the procedure requirements in order for sample

analysis to proceed. If the criteria are not met, any samples analyzed after the last successful continuing calibration standard must be re-analyzed.

6.7.2.3 Linear Range Analysis

At least yearly, a Linear Range Analysis shall be performed for ICP analyses. Any sample exhibiting a result above the upper linear limit shall be diluted and re-analyzed.

6.7.2.4 Instrument Detection Limit

At least yearly, an Instrument Detection Limit study shall be performed. Sample concentration values below the IDL shall not be reported.

6.7.3 Inorganic Analyses

6.7.3.1 Initial Calibration

Initial calibrations shall be performed following the steps outlined in the applicable procedure. Sample analysis shall not begin until an acceptable calibration has been achieved.

6.7.3.2 Continuing Calibration

All General Chemistry procedures, which require verification of the initial calibration, shall follow the specific steps as outlined in the applicable procedure. Samples that are not backed by acceptable calibration verification (either initial or continuing) shall be reanalyzed.

6.8 Instrument Maintenance

All instrument maintenance shall be recorded in an instrument specific logbook. Entries shall be dated and initialed by the analyst making the entry.

6.8.1 Routine

All analytical instruments shall have a routine schedule of maintenance specified by the manufacturer. Routine maintenance should be designed to keep the instrument in good operating condition with as little "down-time" as possible. All Analysts should be proficient in maintaining the instruments for which they are responsible.

6.8.2 Non-Routine

Any maintenance which must be performed in order for sample analysis to proceed, but is not part of the systematic maintenance schedule, is considered non-routine. Non-routine maintenance must be reported to the Section Supervisor immediately so that is its impact on production can be determined. If the ability to analyze samples is adversely affected, the Section Supervisor shall notify the appropriate manager so that alternative action can be coordination with the client.

Note: See section XXX for complete instrument maintenance summary.

6.9 Analysis of Duplicates

The analysis of sample duplicates that contain detectable quantities of analytes is an effective means for assessing the precision of an analysis. Refer to the individual analytical procedures for guidance concerning the frequency and criteria for sample duplicate analyses.

6.10 Control Charts

Control charts are basic tools for quality assurance/quality control. They provide a graphical means to demonstrate statistical control, monitor a measurement process, diagnose measurement uncertainty, monitor trends and aide in method development and troubleshooting.

6.10.1 Organic Department

6.10.1.1 GC Section LCS Spike Recovery

The GC Section shall analyze a LCS with every analytical batch. Analytes and spiking levels used shall be designated in the appropriate procedure. Method accuracy shall be monitored, documented and controlled by GC analysts using control charts of LCS Surrogates % Recovery. Select target analytes, in addition to surrogates, may be monitored on control charts (e.g. Aroclor 1254).

6.10.1.2 GC/MS Section LCS Spike Recovery

The GC/MS Section shall analyze a LCS with every analytical batch. Analytes and spiking levels used shall be designated in the appropriate procedure. Method accuracy shall be monitored, documented and controlled by GC/MS analysts using control charts of LCS surrogate % Recovery. Select

target analytes, in addition to surrogates, may be monitored on control charts (e.g. p-dioxane).

6.10.2 Inorganic Department

6.10.2.1 Trace Metals LCS Spike Recovery

Trace Metals analysts shall prepare and analyze a LCS with every analytical batch. All spikes shall be added BEFORE digestion. Analytes and spiking levels used shall be designated in the appropriate procedure. Method accuracy shall be monitored, documented, and controlled by the analysts using control charts of LCS Analyte % Recovery.

6.10.2.2 General Chemistry LCS spike Recovery

When applicable, all general chemistry analyses shall include a Laboratory Control Sample. Analytes and spiking levels used shall be designated in the appropriate procedure. Method accuracy shall be monitored, documented and controlled by the analysts using control charts of LCS Analyte % Recovery.

6.11 Use of Quality Control Charts

6.11.1 Guidelines for QC Charts

The following guidelines shall be followed in implementing and utilizing QC Charts:

- Each analytical section shall plot the percent recovery of the LCS analyte versus the date of preparation or analysis; whichever is most appropriate.

- For organic analyses employing surrogates, the LCS surrogate % recoveries will be monitored on QC Charts. The recovery of at least one target Aroclor (PCB) in the Pesticide/PCB LCS will be monitored on a QC Chart (e.g. TPH).

- For trace metals determined by inductively coupled plasma (ICP) at least three metals spiked in the LCS must be monitored on QC Charts (e.g. Cd, Cr, Ni). For trace metals determined by graphite atomic absorption (GFAA) and cold vapor atomic absorption (CVAA), a LCS for each element must be monitored on a QC chart.

- For General Chemistry, an appropriate LCS for each method must be used. Each LCS analyte recovery method is monitored on a control chart.

- Initial control limits are established by the section prior to the calculation of in-house limits. These preliminary limits may be derived from published method criteria if available. If no such criteria are available, the preliminary limits will be mutually set and agreed to by the Section Supervisor, Laboratory Manager, and Quality Assurance Manager. A minimum of 20 points is recommended to establish the initial calculated control limits. In some cases, it may be appropriate to use fewer data points to establish the first set of calculated limits, however, at no time should fewer than seven data points are used.

- Control chart limits shall be updated periodically when sufficient additional data points are available. Typically, limits will be updated for each set of 20 to 50 new data points. More frequent updates may be warranted in some cases. Limits must be revised whenever a method is modified and when a change occurs in recovery data, which indicates the need for revised limits (e.g. an observed bias from a new instrument or standard.).

- Each control chart shall have upper and lower **warning** limits established at ± 2 standard deviations ($2\sigma_{n-1}$) from the mean % recovery (centerline).

- Each control chart shall have upper and lower **control** limits established at ± 3 standard deviations ($3\sigma_{n-1}$) from the mean % recovery (centerline).

- Data shall be entered by the analyst performing the method. The data shall be evaluated frequently to identify trends that might occur in an "out of control" situation.

6.11.2 "Out-of-Control" Conditions on Laboratory Control Samples

6.11.2.1 "Out-of-Control" Conditions

Any of the following control chart conditions indicates the loss of process control:

- Any one point is outside the control limits.

- Any three consecutive points are outside one of the warning limits.
- Any eight consecutive points on the same side of the centerline.
- Any six consecutive points are such that each point is larger (or smaller) than its immediate predecessor.
- Any obvious cyclic or repetitive pattern is seen in the points.

6.11.2.2 Reactions to "Out-of-Control" Conditions

In the event of an "out-of-control" condition, the analyst should respond to the condition in the following manner:

- Stop analysis
- Investigate the root cause of the failure
- Implement any required corrective action
- Document the situation in a non-conformance memo prior to initiating subsequent analyses.

The exact circumstances surrounding the variety of "out-of-control" conditions that may be encountered are beyond comprehensive discussion in this procedure. Warning conditions indicated on a control chart may only require more frequent observations of a piece of instrumentation whereas "out-of-control" conditions require shutting down an instrument, investigating root cause and implementing corrective action before restarting the process. In the event that the "out-of-control" event cannot be corrected by the analyst, a NCR should be issued and passed on to the next level of review. ***See section 7.1.***

6.11.3 Quality Control Chart Reviews

The QC chart shall be reviewed by the analyst every time a data point is entered.

The QC charts shall be reviewed for trends and bias.

A trend is a tendency in the data towards a specific direction, i.e. a loss of randomness. A trend in the QC Charts may necessitate more frequent observations of the instruments, analytical technique and/or procedure.

A Quality Assurance review of QC charts will be performed on a periodic basis as a part of ongoing surveillance activities. These surveillance activities shall be documented.

6.12 Identification of Analytes

6.12.1 Organic Analyses

The identification of analytes must be accomplished with standards of known and traceable quality. All standards shall be traceable as per the applicable analytical procedure.

6.12.1.1 Gas Chromatography

All sample identifications shall be made based on the retention time of the analyte as determined. The identification of any analyte, which is identified during the primary analysis, shall be verified using a confirmation column unless specifically exempted in the applicable procedure.

6.12.1.2 Gas Chromatography/Mass Spectrometry (GC/MS)

For positive identification of an analyte by GC/MS, the spectrum of the analyte must conform to a spectrum of the authentic standard obtained after satisfactory tuning of the mass spectrometer. The appropriate analytical methods should be consulted for specific criteria for matching the mass spectra, relative response factors and relative retention times to those of authentic standards. Tentative identifications may be made based on conformance to published mass spectra in reference texts or spectral library databases.

6.12.2 Inorganic Analyses

The identification of analytes must be accomplished with standards of known and traceable quality. All standards shall be traceable to an approved reference material.

6.12.2.1 Metals

The concentration of a metal analyte is based on the absorption of emission of light measured at a specific wavelength. The wavelength selected shall be per the applicable procedure. Standards used to generate the calibration curve shall be traceable to NIST or other nationally recognized (e.g. EPA).

6.12.2.2 Wet Chemistry

Standards used to prepare calibration curves or to standardize instruments shall be traceable to NIST or other national source (e.g. EPA).

6.13 Quantification and Reporting of Analytes

6.13.1 Reduction of Sample Data

Data reduction shall be defined as the processing of instrument generated number by an analyst to achieve a final result for sample analysis as well as quality control criteria. Processing of numbers may be achieved using manual calculations and/or computer aided calculations.

All data reduction shall follow calculations found in approved procedures for the analysis.

All data reduction shall be performed by an analyst who is qualified to perform the analysis. If a Section Supervisor performs data reduction, the data shall be reviewed by another qualified analyst.

All numbers used in the reduction of data should be present on data reports or shall be easily retrievable.

All computer-generated calculations shall be performed using a validated program/spreadsheet.

6.13.2 Reporting Data

6.13.2.1 Significant Digits

All digits in a reported result are expected to be known definitely, except for the last digit, which may be in doubt. Such a number is said to contain only significant figures. If more than a single doubtful digit is carried, the extra digit or digits are not significant. The following rules apply to all reported analytical results from all laboratory sections:

- All digits from a measurement shall be recorded. These numbers shall be used in the calculation of the results. After all calculations have been performed, the number shall be rounded to the required number of significant digits.

- The number zero may or may not be a significant digit, depending on its placement of the reported result.

- Final zeros, after a decimal, are always significant (Ex. 9.80 has three significant figures).

- Zeros before a decimal point with non-zero digits preceding them are significant. Zeros with no non-zero digits before them are not significant (Ex. 10.3 has three significant digits, 0.53 has two significant digits).

- If there are no non-zero digits preceding a decimal point, the zeros after the decimal point but preceding other non-zero digits are not significant. These zeros only indicate the position of the decimal point.

- Final zero in a whole number may or may not be significant.

- A good measure of the significance of one or more zeros interspersed in a number is to determine whether the zeros can be dropped by expressing the number in exponential form. If the zeros can be dropped, then they may not be significant.

- When mathematical functions are performed on multiple numbers, the number with the least number of significant digits dictates how many significant digits the end result should have.

Rounding Rule

Once the number of significant figures obtainable from a particular analysis is established, data resulting form the analysis are reduced according to the set rules for rounding off.

Rounding off numbers is a necessary operation in all analytical sections of the laboratory. It is automatically applied by the limits of measurement of every instrument and all glassware. However, when it is applied in chemical calculations (i.e. data reduction) incorrectly or prematurely, it can adversely affect, or bias the results.

6.13.2.3 Reporting Units

All sample results reports shall be accompanied by the appropriate unit of measurement (i.e. matrix spike).

6.13.2.4 Wet vs. Dry Weight Basis

When required, non-liquid sample results should be reported on a dry weight basis and it should be documented in the report. When results are reported on a wet weight basis, the results are reported "as is".

6.13.2.5 Reporting % Recovery and RPD

Unless otherwise directed by the customer or the QA Manager, the % Recovery and RPD shall be reported to one decimal place.

6.14 Storage of Quality Related Data

All data and information, which pertains to a project, must be retained by the laboratory.

6.14.1 Calibration Data

All calibration data, which pertains to a specific project, shall be stored in an easily retrievable manner. Easily retrievable manner shall be defined as same day for current projects, or within 24 hours for archived projects.

6.14.2 Quality Control Data

All quality control related data (i.e. blanks, blank spikes/duplicates, matrix spikes/duplicates, etc.) shall be stored in the associated project file. If more than one project is associated with the QC data, copies shall be made and stored with each associated project.

6.14.3 Logbooks (Notebooks)

Laboratory logbooks shall be kept in the laboratory while in use. Once completed, the logbooks will be archived in an easily retrievable location.

6.14.4 QC Charts

QC Charts while in use shall be stored in the laboratory by the appropriate instrument, on the computer network, or in a central location. When the QC

Chart is no longer being used, it shall be archived by the section in a central location.

6.15 Internal Performance Audits

Internal performance audits are a means for the Quality Assurance Department to determine the applicability of procedures, the effectiveness of procedures and the utilization of procedures by all sections. Performance audits will be performed by designated personnel. At the beginning of each new year, and on an on-going basis, a schedule of audits and surveillance will be developed and updated by the Quality Assurance Section. Surveillance will be performed on an unannounced basis with the sections so that objectively may be maintained. Findings from audits and surveillance will be documented and corrective actions implemented. Additional surveillance should be scheduled to ensure that all deficiencies are corrected.

7.0 FAILURE OF QUALITY CONTROL

When there is a quality control failure that impacts data quality, the event must be reported. Notification to the Quality Assurance Manager is mandatory.

7.1 NON-CONFORMANCE

7.1.1 A non-conformance is defined as any occurrence that prevents the laboratory from delivering data that is compliant with the control criteria established, published or referenced by a specific method, protocol or quality assurance plan.

7.1.2 Non-conformance Report

A NCR is issued when an event occurs that prevents the data from being reported within the criteria established by the QA program, method, SOP or other controlling protocol anytime during an analysis. The NCR is used to determine the appropriate procedure to correct the nonconforming event. The NCR is issued by the supervisor or manager where the event occurred and is tracked by that department until the NCR is resolved. At that time, the QA department officially closes the NCR. Should management determine that further investigation into the event is required, a corrective action report would be issued as outlined in section 7.2.

7.2 CORRECTIVE ACTION

Deficiencies in analytical procedures, materials, components or methodology may lead to the release of incorrect analytical results to the client. Once a deficiency has been identified, corrective actions must be implemented to prevent reoccurrence of the deficiency. To document and track the corrective action(s), a Corrective Action Report

(CAR) is issued. The CAR is issued to the responsible management personnel by the QA Department and a copy of the CAR is maintained in the QA files.

7.2.2 Corrective Action Report

A CAR is issued when a NCR, QA audit, either internal or external, reveals circumstances that may adversely affect quality as determined by the QA Manager. A CAR may be issued at any time when procedural or technical problems arise and the QA Manager determines that it may significantly affect quality. Guidance that is more specific is outlined in AES document

7.2.2.1 Procedures and Responsibilities

It is the responsibility of the QA Manager to issue and track the completion of CARs. The assigned personnel are responsible for completing the corrective action within the specified time frame. Detailed information can be found in AES document

8.0 QUALITY ASSURANCE RECORDS

8.1 General

Where necessary, records are generated and maintained for all quality associated activities conducted during all phases of the analytical work. QA records provide sufficient evidence that all specified QA requirements have been accomplished and satisfied and provide sufficient documentation to substantiate all reported findings and conclusions.

These records are retained by AES after the issuance of the report for a minimum time period specified by the QA Manager, Manager, the client or regulatory requirement. This ensures the availability of the QA historical information. The following types of records shall be identifiable and retrievable:

- General QA Records – Records pertaining to procurement activities; results of reviews and audits; qualifications of personnel; Standard Operating Procedures and Document Control Records are generated and maintained as a minimum.

- Inspection and Test Data Records – Records pertaining to in-process inspection and test; Equipment Logs and Maintenance Logbooks are generated and maintained as a minimum.

- Raw data generated, reports, etc.

8.2 Procedures and Responsibilities

It is the responsibility of the appropriate Manager and the QA Manger to identify records which will be required, assign responsibilities to individuals or departments for maintaining specific records and specify the retention periods for these records. It is the responsibility of the QA Manger to issue and track the completion of CAR. The assigned personnel are responsible for completing the corrective action within the specified time frame.

It is the responsibility of the appropriate manager to maintain certain customer documents for the period of time specified by the customer if that time exceeds the QA Manger's minimum time requirement.

9.0 SAMPLE CUSTODY

9.1 Sample Custody Objectives

AES has implemented sample chain-of-custody procedures to provide accurate, verified, and traceable records of sample possession and handling from sample container shipment through laboratory receipt and sample disposition.

Evidence of documentation of sample collection, shipment, laboratory receipt and custody is accomplished utilizing a chain-of-custody record (Figure XX). A sample is considered in custody if it is:

- in actual possession of the sampler or courier
- in view after being in physical possession of the sampler or courier
- sealed so that sample integrity will be maintained while in possession of the sampler or transferee
- in the secured area, restricted to authorized personnel

9.1.1 Custody Record Maintenance

Laboratory records, including copies of the chain-of-custody forms and any other associated documentation, are maintained in a secure area with other associated project records. Laboratory data are recorded in bound notebooks and entries are made in waterproof ink. Laboratory data entry errors are deleted with a single-line through the error. Correction tape or other substances designed to obliterate documentation are strictly prohibited in the laboratory or custody areas. The correction is initialed and dated by the analytical staff member making a change. Laboratory information is documented on prepared forms. All forms for recording laboratory data include spaces for date and initials which must be completed by the data recorder. Laboratory documentation not recorded on prepared forms is also dated and initialed.

9.2 Sample and Legal Custody Procedures

All samples are received by the custody technician under either routine or special legal chain-of-custody procedures. Legal custody is a special type of sample custody in which all events associated with a specific sample are documented in writing.

9.3 Laboratory Custody Procedures

The following procedures apply to the custody activities employed by AES during sample or legal custody procedures.

9.3.1 Selection and Preparation of Sample Containers Supplied to a Client

Sample containers provided by AES are manufactured from EPA-designated materials, contain EPA-prescribed preservatives and are affixed with an AES identification label (Figure XX). In order to monitor container temperature, a 100-mL plastic container labeled "Container Temperature- For Laboratory Use Only" is pre-filled with tap water and supplied with each sample shipment to monitor sample temperature upon receipt.

Pre-cleaned sample containers are purchased by AES. Containers from each lot are pre-certified in house prior to use. The lot number is affixed to each container for purpose of traceability.

9.3.2 Chain of Custody Documentation, Traceability, and Sample Integrity

Formal chain-of-custody procedures are initialed by a custody technician who is responsible for organization and relinquishment of sample containers to the client or field personnel.

All field information must be properly recorded on the chain-of-custody form. Proper completion of the form is the responsibility of the client's field sampling manager and is required prior to relinquishment of the samples. If the site location is different from the client address, the site location is recorded in the "Project Name" space on the chain-of-custody form, or on the right hand side of the form if additional space is required. The sample identifications assigned in the field are recorded in the "Sample Identification: column. Common carriers may identify themselves by signing the "Relinquished By" space on the chain-of-custody form.

For samples transported from the field to the laboratory by common carrier, chain-of-custody is maintained. Completed custody forms must accompany

each sealed cooler, and are placed in a plastic bag and taped to the inside lid of the cooler. A copy of each air bill package tracking form associated with a shipment of samples is maintained in the appropriate client files.

The custody-technician is responsible for the inspection of shipping containers upon laboratory receipt for overall integrity and to ensure that the contents have not been altered or tampered with during transit. If tampering is apparent, the sample receipt custodian immediately contacts the assigned project manager who is responsible for client notification. The cooler inspection form, filed by the sample receipt custodian, describes the deficiency and annotates any corrective action required by the client. Any appropriate changes are documented on the accompanying project chain-of-custody form, which is dated and signed by the sample custodian or project manager.

If shipping containers arrive intact, they are immediately opened by the sample receipt custodian in the receiving area, and the chain-of-custody form and temperature container removed for inspection. Container temperature upon receipt is documented in a bound sample registry or if requested by the client, documented on the chain-of-custody form.

9.3.4 Sample Documentation, Identification, and Login

A sequential laboratory identification number is assigned to the project and recorded on the chain-of-custody form, on each sample container submitted with the project and in the bound Sample Registry. Accurate and complete sample documentation must be provided on the chain-of-custody form in order to log samples into the sample registry. The sample registry includes all information necessary to maintain chain-of-custody including laboratory ID, client (field) ID, and initials of the sample receipt custodian. Ancillary information such as sample collection date and requested analyses is transferred directly from the chain-of-custody form into the LIMS, and appears on the client project-specific acknowledgement.

Once the chain of custody is verified, the project identified by this unique number is logged into the computerized LIMS (Figure 12.1) to transfer the desired work order request to the laboratory. The sample receipt custodian checks each sample against the chain-of-custody form for discrepancies between information on the sample label and information provided on the chain-of-custody form. The sample receipt custodian also inspects all samples for leakage or obvious seal tampering (if provided). All samples are unpacked in a well-ventilated sample receipt area. Samples received in plastic containers which appear to be accumulating or evolving gas are treated cautiously and inspected under a chemical hood because they may contain toxic fumes or be of an explosive nature.

At client request, a "Cooler Receipt Form" (Figure XX) can be completed to document custodial concerns at sample login.

Discrepancies noted by the custody staff are transmitted to the project and sample manager and are resolved with the client prior to laboratory work assignment. Discrepancies are documented on the Anomaly Report. The project manager and the sample manager attempt to resolve custody discrepancies expeditiously to avoid holding time compromises. After a decision concerning a sample has been made, the project manager or sample manager makes an initialed note on the original custody form which states person notified, time, date, and resolution, if applicable. This information is also documented on the sample custody excursion form. A faxed or hard copy of custodial resolutions or project order alterations is secured from the client prior to work initiation. Copies of this documentation are mailed to the client and maintained in the client file.

9.3.5 Sample Preservation

After addition of the project sequential identification number, the samples are distributed to the appropriate laboratory section sample storage areas. Color-code dots and unique sample bottle types correspond to specific analysis and are stored at designated sample storage areas throughout the laboratory sections. Bound sample storage temperature logs are maintained for all sample storage refrigerators to assure proper temperature maintenance throughout the analytical process.

All samples received by AES are checked for proper pH adjustment by the appropriate preparation or analytical department as soon as possible. The pH of each sample is checked, documented, and adjusted, if necessary. To avoid compromising sample integrity, volatile sample are checked for proper pH adjustment only at the time of analysis. The pH of volatile samples is not adjusted.

9.3.6 Sample Security, Accessibility, Distribution, and Tracing

Only authorized personnel are permitted within the laboratory areas where sample access is possible. Sample storage areas are designed to segregate volatile and nonvolatile samples. Standards and extracts are also departmentally controlled and stored separately.

The set of analyses required for a group of samples is project-dependent. After sample registry login and verification, samples are relinquished from the receiving area to the appropriate sample preparation area. Those samples not requiring preparation are relinquished immediately to the sample analysis

storage area. Using LIMS-generated sample preparation worksheets for guidance, samples are extracted, digested, or distilled as appropriate. The extracts, digestates, or distillates are then transferred and relinquished to the appropriate analysis section, where analysis is performed. An example analysis log.

For projects where in-laboratory custody records are required by the client, the AES project manager should inform the custodian and sample manager to coordinate custody activities prior to sample receipt. For those samples, department-specific in-laboratory sample tracking forms are executed by department staff. Samples and sample preparations are stored in approved sample storage areas.

Sample holding times are tracked via the LIMS. Sample collection dates are routinely entered into the LIMS with all sample logins. This information allows holding times specific to each departmental analysis to be tracked by department managers, supervisors, chemists, and analysts through the use of daily status sheets, reference sheets, and preparation worksheets. Date analyzed is recorded via instrument outputs or analysis forms when applicable as an integral part of the raw data. Upon the analysis of each parameter, the date of analysis is entered into the LIMS and can be compared to the date sampled to validate that holding times have not been compromised.

9.3.7 Sample Disposition Documentation

Upon completion of analytical work, sample custody of unused sample portions, extracts, or digests is relinquished to a central secured storage area. Here the samples, digests, or extracts await disposal, which is performed with the assistance of the LIMS. The LIMS stores clients specific disposal instructions, complies results from the analyses of composited samples, prepares sample disposal lists, invoices for disposal and sample return costs, and provides a disposal record for all excess samples.

9.4 Electronic Data Records

By careful assignment of user passwords and file access/lock codes, AES maintains a high level of data security for the LIMS. Thus, only authorized AES personnel can access client files to view data. In addition, data entry and editing is restricted to highly trained data management personnel.

Data may be downloaded in a variety of standard formats including ASCII, Spreadsheet, Database, or Text files such as *.ASC, *.WK1, *.DBF, *.TXT, etc. Additionally, lab data may be formatted to match client-specific requirements. These requirements should be defined and agreed upon prior to project commencement.

Laboratory-generated data are thoroughly reviewed prior to preparation of electronic or diskette deliverables. The download process includes both electronic and logical error check routines to confirm the data files delivered are consistent with the client's format and data content request. A signed hardcopy report will be provided with all electronic or diskette deliverables and an electronic and documentation audit trail of each download event will be maintained.

In order to ensure data integrity and security, all files selected for data downloads are transferred from the LIMS to an isolated PC computer system. Access to download files is then controlled via required matches of log-on sequences and confidential passwords. The entire download process is regularly reviewed and maintained by the computer department for system performance.

Internal documentation is maintained by the LIMS manager for all LIMS programs. This documentation includes descriptions of any program additions, deletions, or modifications, the date of revisions, and the initials of responsible programmer. To verify proper program functioning of the hardware and software, a simulation account is maintained. When hardware or software is modified, the LIMS uses actual data in the simulation account in order to verify the modifications are functioning as anticipated. Anti-virus software serves the LIMS as a protective measure.

Entry of data into the LIMS is a accomplished through direct instrument interface and manual entry by data technicians from the chemists worksheets, immediately following data entry, approval sheets are printed with the entered data as it appears in the LIMS. Assistant project managers compare all data on the approval sheets against the chemists' worksheets for data transcription errors.

9.5 Verification of Hard Copy Records

Data worksheets, data approval forms, and final reports are routinely printed for verification and signatures. Hard copies of final reports, field data, chain-of-custody forms, and any ancillary documentation pertinent to the project will be stored in a secured storage area and placed chronologically within alphabetically arranged client files.

9.6 Facility Security

AES operates under a security policy. Under this policy, all external doors are either visually monitored by AES staff or kept locked. Visitors are required to sign in, and wear a visitor's badge during their visit. They are accompanied at all times by an AES staff member when in the laboratory.

10.0 REAGENT STORAGE AND DOCUMENTATION

Reagents are stored with consideration for safety and maximum shelf life. Storage conditions and documentation maintenance status for various classes of reagents are given in Table XX, as well as discussed below.

All acids, except those poured up in small marked containers which are immediate use, are stored in the original containers within acid storage cabinets.

All bases, except those poured up in small containers for immediate use and those that are standardized for specific purposes, are stored in the original containers within designated areas or storage cabinets.

All flammable solvents, except those poured up for immediate use are stored in original containers in approved vented flammable storage cabinets which are located indoors.

Dry reagents are stored in designated cabinets in cool, dry areas. Reactive chemicals, cyanides and sulfides are labeled and isolated from other chemicals.

All acids used for metal sample digestions and all solvents used for semivolatile sample extraction are tested prior to initial use. Lot numbers used for digestions or extractions are recorded in bound notebooks in the appropriate departments.

Reagent blanks are analyzed with each sample batch for all methods, validating the purity of all reagents. All reagent containers are dated when received, and dated initialed when opened (except high use items consumed in less than one week). Documentation is maintained to provide traceability of the reagents used with the analysis of any batch to specific reagent lot numbers.

11.0 WASTE DISPOSAL

AES operates as a conditionally exempt small quantity generator.

All waste disposal is carried out in accordance to AES' Waste Disposal SOP. This document includes procedures for identification, storage, personnel training, tracking forms, report forms, safety, as well as details of the disposal. Hazardous waste disposal procedures are given in Table XX and discussed below.

Hazardous wastes must:

- be stored in non-leaking containers in good condition with close-fitting lids and kept closed when wastes are not being added or removed.
- Be accurately labeled with waterproof labels. Labels must specify the words "Hazardous Waste", the composition and physical state of the waste, the hazardous properties of the waste (e.g., flammable, reactive, etc.), and the name and address of the generator.

- Be clearly labeled on each container with the date that the period of accumulation began. The date must also be documented on the Hazardous Waste Tracking Log Form.
- Be handled in containers and in a way that minimizes the possibility of spills and escape of wastes into the environment.
- Be stored in an area which is regularly inspected for deteriorating or leaking containers.

All waste must be segregated for temporary accumulation and storage as well as for disposal. Care must be taken to combine waste materials into categories or waste streams based upon their compatibility.

The following three types of waste are stored in 55-gallon drums.
1. Halogenated solvents such as methylene chloride (closed cap metal drum)
2. Nonhalogenated flammable solvents (closed cap metal drum)
3. Heavy metals or other aqueous wastes except cyanide (poly drum)

All other wastes should be stored in the original container or 4-liter glass bottles and disposed of via a "lab pack". (Packed by a disposal company in 55-gallon open top drums.)

11.1 Sample Disposal

After analysis completion, unused sample portions, extracts, or digests are transferred to a central secured storage area to await disposal. Unless a client requests the project manager to save unused samples, digests, or extracts, disposal from the central storage occurs as soon as holding times have expired or three weeks after results submission.

Requests for extended sample, digest or extract storage must be provided by the client to the AES project manager in writing (contract form) prior to sample receipt. Extended storage may result in additional fees to be negotiated by the AES project manager prior to sample receipt. AES is not responsible for evaporation or other deterioration of samples, extracts, or digests during extended storage periods.

Samples which are requested to be returned to the client may be picked up at the laboratory by the client, shipped by Federal Express (at the client's expense for packaged shipping) or returned by any other legal means that is arranged by the client. Clients requesting the return of samples should provide detailed shipping instructions.

If a client by contact requires that samples to be disposed of by a hazardous waste contractor, the client's name and EPA ID number are used on the manifest and the client is billed for all disposal related costs.

Other excess sample portions will be composited according to matrix (solids, oils or aqueous) by the laboratory. The composited soils, sediments and other solid samples are sub-sampled and analyzed for hazardous waste characterization: ignitability, reactivity, (releasable cyanide and sulfide), corrosivity (pH), toxicity (TCLP by SW-846 Method 1311) and PCBs. If the pooled sub-sample is characterized as hazardous by any of the

hazardous waste characteristics or contains greater than 50 ppm PCBs, the composited excess sample is disposed of by a hazardous waste contractor. If the pooled sub-sample is not deemed hazardous per these tests, the composited excess material is disposed of in an industrial/municipal landfill.

Aqueous samples that are neutralized and disposed of via the municipal sewer system as long as the discharge requirements as outlined in 40 CFR Part 261.3 (a)(2)(iv)(E), are met.

12.0 STANDARD RECEIPT AND TRACEABILITY

Standards are purchased from commercial sources in mixes designed for the specific methods or as neat compounds. Certificates of analysis are shipped with each ampule by the vendor. When possible, standards are certified to meet or exceed the criteria established by the U.S. EPA or are traceable to NIST standards.

Upon receipt, dates are placed on all standard materials. Standard logbooks are maintained by all sections of the laboratory to document the traceability of working standards back to neat materials or prepared stock mixes. All standards are assigned a lot number that provides a unique identification as well as identifying the type of standard. This unique lot number is documented in a laboratory notebook along with date of preparation, initials of preparer, concentration, expiration date (if applicable), and solvent (if applicable). If required, a standard preparation narrative is also provided in this notebook to detail the preparation steps for each stock standard.

13.0 PREVENTIVE MAINTENANCE

13.1 Maintenance Schedule

AES is equipped with up-to-date computerized instrumentation. In order to gain maximum performance and minimize downtime, regular inspection, maintenance, cleaning, and servicing of all laboratory and field equipment is performed according to the manufacturers' recommendations. A maintenance log is kept for each piece of laboratory and field instrumentation, detailing all maintenance performed on the instrument. Routine repairs and maintenance are performed and documented by the analyst responsible for the particular instrument. Non-routine maintenance is signed and dated by the analyst or repair technician. Routine maintenance procedures for laboratory instrumentation are given in Table XX. The service intervals listed in Table XX are as follows: D = daily; W = weekly; M = monthly; Q = quarterly; SA = semi-annually; AN = as needed.

An extensive spare parts inventory is maintained for routine repairs at the facilities, consisting of GC detectors, AA lamps, fuses, printer heads, flow cells, tubing, certain circuit boards and other common instrumentation components.

14.0 DATA REDUCTION, REVIEW, AND REPORTING

14.1 Introduction

In order to provide the highest quality data possible, an extensive system for sample custody, data reduction, review, and reporting has been implemented.

14.2 Sample Custody

Upon receipt of the samples, the custody forms are checked against the sample identifications listed on the containers by the custody technicians, and a unique AES log number is assigned to each sample group. Any discrepancies are noted, including cooler temperatures, broken bottles and/or misidentified samples. Clients are immediately notified if discrepancies exist.

After receipt, the samples are delivered to the appropriate laboratory sections where the samples are checked for proper preservation and this information is recorded in bound notebooks when applicable. When necessary, the samples are then stored in refrigerators that are monitored at least daily for temperature.

14.3 Organization and Initiation of Sample Analyses

The key to AES' sample flow, analysis, data/QA review, archiving, and reporting system is the single LIMS network which controls the day to day production of the laboratory. This system provides project managers, QA personnel, and all analysts immediate information on the status of any sample. This system schedules and prioritizes all work, provides a mechanism for sample tracking, review of reportable and QC data, generation of reports and invoices, and archiving of all reports and associated QC data.

Upon receipt of custody forms, the project manager instructs data management personnel to log the sample analysis request and identification into the LIMS. This enables any project manager, section manager, QA manager, laboratory director, or analyst with authority to access and check the status of all projects.

After the sample analysis request is logged into the LIMS and approved, the LIMS generates worksheets that are printed and distributed.

14.4 Sample Analysis and Data Reduction

Through the use of the worksheets the samples are prepared following the procedures given in each of EPA's approved methods. The preparation information is recorded in bound notebooks throughout the laboratory.

14.4.1 Data Reduction

Most sample concentration results are read directly from instrumentation without further reduction or calculations. Dilution factors are applied upon the dilution of samples having concentrations above the calibration range. In many cases, these are input into the instrument computer and correct results are calculated automatically. In other cases, a manual calculation may be made.

Data form methods requiring reduction prior to reporting include titrimetric methods, BOD, COD, conductivity, manual UV/VIS/IR and residue.

All laboratory pH meters are temperature compensated.

The laboratory raw data containing the instrument-generated reports, manually calculated results, and all supporting preparation, calibration, and analytical data are retrained at the individual work stations until reports are issued unless additional handling or data packaging required.

14.4.2 Chromatographic and Data File Identification

Chromatograms and data files are given a unique alphanumeric identification by the chemists initiating the analyses in each section where appropriate. These file identification numbers reflect either the date the sequence was initiated (GC sections), the order in which the samples were analyzed (GC/MS sections), and/or the sample identification and log numbers given by the client and listed on the LIMS.

14.5 Data Transfer and Review

14.5.1 Data Transfer to LIMS

The analytical results are entered on the department worksheets after review or by direct electronic transfer from the instrument data system. The worksheet data are entered into the LIMS by the data entry technicians. After the data are entered into the LIMS, approval sheets are printed and checked against the information entered into the LIMS for transfer errors and anomalies.

14.5.2 Data Review

Laboratory analytical results are reviewed by at least two analysts or a section supervisor. Prior to entering the reportable data into the LIMS, laboratory raw data have been reviewed, stamped, and signed to ensure that all of the method specifications have been met. This includes checking the extraction, digestion, distillation, and other preparation logs, as well as ensuring that all precision and

accuracy requirements are addressed, and all steps of the analyses have been completed. If any problems arise during the analysis of the sample batch, it is the responsibility of the analyst and the section supervisor to bring this to the attention of the project manager, section manager, and QA manager through a written corrective action report.

Data flags are used on reports as needed to inform the project manager and the client of any additional information that might aid in the interpretation of the data. The data flagging system incorporates data qualifiers which are similar to flags specified in the Contract Laboratory Program protocols, as well as additional flags used to help explain batch specific events.

When data acquisition and reporting have been completed, the project manager reviews and prepares the final report. Because the project managers have extensive experience in evaluating analytical data, they have developed both objective and subjective techniques for data review. Each value reported is reviewed in the context of the respective environmental matrix and all available QC/QA data. Abnormal values are carefully scrutinized, and samples are reanalyzed if the abnormalities cannot be explained. Where there are cases in which the results from spiked samples suggest interferences, attempts are made to remove the interferences, or alternate analytical procedures are used. If the interference problem cannot be resolved, the data are flagged and/or a project narrative is included with the report.

14.5.3 Special Project or Data Package Review

If special handling and/or data packages are requested by the client, QA personnel also review the project report and the raw data. This includes checking that holding time requirements are met, checking calibrations, reviewing all quality control data and/or control charts, and initiating any corrective action or re-analyses that might be appropriate.

14.6 Reporting

The final report is printed and signed by the project manager after all review has been completed. The data flags that may appear in a project report are defined on the signature page, and any additional comments are also footnoted on this page.

If requested by the client or a project specific QA Plan, custom reports or data packages can be provided. If data packing is requested, a paginated data package is provided in addition to the project report. The format of the project report and/or data package can be adjusted to meet the needs of the client. All LIMS reports can be downloaded onto diskettes or to most clients' computers.

15.0 PROCUREMENT DOCUMENT CONTROL

15.1 General

Vendors of analytical material supplied to AES are regarded as a resource to and an extension of the laboratory organization. The standards for quality identified in this document shall be applicable to vendors.

The purpose of the procurement control criterion is to ensure the quality and traceability of procured quality related items (equipment, materials, or services), whose specification could affect the quality of the services of AES. This includes such quality related items as the calibration of instruments by outside laboratories (when appropriate), purchase of standards, subcontracted services and materials requiring testing before use, as determined by the QA Manager.

15.2 Procedures and Responsibilities

It is the responsibility of the purchase requisitioner to provide assurance, when required, that all applicable regulatory requirements, industry codes and standards appear in the purchase documentation for affected services and products.

Purchase orders are retained by the Purchasing Department for control purposes.

Purchased items which do not meet the minimum standards set forth by the purchase requisitioner are processed according to procedures set forth in Section 16.9, "Nonconforming Items".

The appropriate Manager/Supervisor and QA Manager review purchase orders, which may affect quality-related services or products.

Purchase orders for standard catalog items except those described in 15.1, are exempt from QA review.

APPENDIX I

WASTE DISPOSAL PROCEDURES

Waste Type	Associated Analytical and Sample Prep Methods	Storage Procedures	Disposal Procedures
Halogenated Solvents Methylene Chloride	Pesticides, Herbicides, BNA, GPC, etc.	Store in glass bottles, then in drums.**	Reclaimed by HW contractor.
Freon	Oil & Grease, Petroleum Hydrocarbons	Store in glass bottles.	Reclaimed by laboratory.
Mixed Solvents (Flammable & nonhalogenated)	VOC Standards, Herbicides, Pesticides	Store in glass bottles, then in drums.	Disposal by HW concractor.
All neat standards	All analyses	Store in orijinal bottles of glass/plastic bottles, then lab pak.	Disposal by HW concractor (Packed by also)
Heavy Metals Solutions	Metals, COD, Chloride	Store in glass bottles, then in drums.	Disposal by HW concractor.
Acid Solutions	Metals, General Inorganics, Extractions	Store in glass bottles or add to neutralizing chambers.	Neutralize; sanitary sewer.
Alkaline Solutions	General Inorganics, Extractions	Store in glass bottles.	Neutralize; sanitary sewer.
All samples containing Organics or Inorganics exceeding hazardous waste standards*	All analytical groups	Store in original bottles or jars in sample custody storage area.	Return to client, or disposal by HW concractor.

* Hazardous Waste Characteristics (D001-D017) (40 CFR Part 261), HCN>250 mg/kg, TCLP Toxicity Characteristics (Federal Register, 55FR 11798), March 29, 1990, or contains greater than 50 ppm PCBs.

** Bottles are kept in each lab and are periodically moved by the Waste Coordinator to hazardous waste storage area.

APPENDIX II

LABORATORY EQUIPMENT PREVENTIVE MAINTENANCE SCHEDULE

	Service Interval							
EQUIPMENT ITEM	**D**	**W**	**M**	**Q**	**SA**	**A**	**AN**	**SERVICE LEVEL**
ICAP								
Pump Turbing				X				Change
Nebulizer			X					Clean
Filters			X				X	Inspect - clean or replace.
Spray Chamber			X					Clean
Quartz Torch					X			Clean and realign.
D-Shaped Mirrors			X				X	Inspect - clean or replace
MERCURY ANALYZER AND AUTOSAMPLER								
Pump Tubing	X						X	Inspect - replace
Standard Cups	X						X	Inspect - replace
Drying Tube	X							Repack
Mixing Coil		X						Inspect - clean or replace
Sample Probe			X					Inspect - clean or replace
Mercury Lamp							X	Clean or replace
CONDUCTIVITY METER								
Battery							X	Check or replace
Probe Contacts							X	Clean or replace
pH METER								
Probe(s)	X							Check fluid levels and fill
Connetors	X							Check for corrosion and clean if necessary
AUTOANALYZER (TRAACS/LACHAT)								
Pump Platen							X	Replace
Pump Tubes				X				Replace
Flow Cell				X				Inspect and clean.
Autosampler	X							Check alignment
Cobalt Column							X	Inspect for channeling and repack
BLOCK DIGESTOR								
Heating Elements							X	Replace as needed
Thermostat					X			Check against calibrated thermometer for accuracy
UV/VIS SPECTROPHOMETER								
Light Source							X	Replace
Belt	X							Check for wear, replace if frayed
Cuvets	X						X	Check for scratches and buildup - replace
ION SELECTIVE ELECTRODE								
fluid filled probe	X						X	Check fluid level - empty and replace if crystals form
solid probe	X							Check for salt build-up on tip, clean if necessary
BOMB CALORIMETER								
Thermometer						X		Calibrate Thermometer
Seals	X							Check for breaks in seals and replace if needed

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LABORATORY EQUIPMENT PREVENTIVE MAINTENANCE SCHEDULE

	Service Interval							
EQUIPMENT ITEM	**D**	**W**	**M**	**Q**	**SA**	**A**	**AN**	**SERVICE LEVEL**
GAS CHROMATOGRAPH - SEMIVOLATILES								
Autosampler System							X	Syringe and tubing cleaned - Needles and tubing replaced
Septa		X						Replace
Column/Injector							X	Chance sleeve and cut front of guard column.
Gas Cylinder	X							Inspect - change when pressure reads <500 psi.
GAS CHROMATOGRAPH - MASS SPEC SEMIVOLATILES								
Column/Injector		X						Chance sleeve and cut front of column.
Septum		X						Replace
Splitless Disc					X			Replace
Autosampler	X					X		Syringe and tubing cleaned Needles and tubing replaced
Rough Pump						X		Oil change by HP service
Mass Spectrometer							X	Clean
Gas Cylinder	X							Inspect - Change when pressure reads <500 psi.
Hard Drive		X						Archive
ATOMIC ABSORPTION								
Pump	X							check for leaks and corrosion
Lamps							X	If intensity drops, replace
Nebulizer		X						Clean, sonicate
Tubing	X							If leaking or weak, replace
Burner Head		X						Clean, sonicate
Bottled Gases	X							Replace if pressure reaches 500 psi.
Spray Chamber			X					Clean, sonicate
GAS CHROMATOGRAPH - VOLATILES								
Column							X	Replace
Septum			X					Replace
Gas Cylinder	X							Inspect - change when pressure reads <500 psi.
Hydrocarbon/Moisture Trap						X		Replace
GAS CHROMATOGRAPH - MASS SPEC VOLATILES								
Column							X	Replace
Rough Pump						X		Oil change by HP service
Gas Cylinder	X							Inspect - change when pressure reads <500 psi.
Septum			X					Replace
Transfer Line							X	Check for leaks
GAS CHROMATOGRAPH - ECD								
Autosampler	X					X		Syringe cleaned Needles and tubing replaced
Column							X	Replace

APPENDIX II

LABORATORY EQUIPMENT PREVENTIVE MAINTENANCE SCHEDULE

	Service Interval							
EQUIPMENT ITEM	**D**	**W**	**M**	**Q**	**SA**	**A**	**AN**	**SERVICE LEVEL**
Septa							X	Replace
Glass Insert							X	Replace
Gold Disk							X	Replace
Gas Cylinder	X							Inspect - change when pressure reads <500 psi.
EC Detector(s)						X		Send off for replacement of radioactive nickel foil.
GAS CHROMATOGRAPH - FID								
Autosampler	X						X	Syringe and tubing cleaned Needles and tubing replaced
Column							X	Replace
Septa							X	Replace
Gas Cylinder								Inspect daily, change when pressure reads <500 psi.
Glow Plug								Determine if glow is enough to ignite Hydrogen
Housing and chimney								Check for rust and corrosion that will cause a short, and clean if necessary.
Glass Insert							X	Replace
Column							X	Replace
PURGE AND TRAP								
Sorbent Trap					X			Change
Heater Pockets	X							Check, replace if defective
Transfer Lines							X	Inspect and replace if needed
Purge Flow					X			Inspect, adjust as needed
TCLP EQUIPMENT								
Volatile Rotator	X							Check rotation (± 30 rpms)
Semivolatiles/Metals Rotator	X							Check rotation (± 30 rpms)
BALANCES								
Top-loading Balance	X							Calibrate, service annually
Analytical Balance	X							Calibrate, service annually
Triple Beam Balance	X							Calibrate, service annually
Auto-Pipets		X						Calibrate
DISSOLVED OXYGEN METER								
Batteries	X							Check for strength, if < 13.20 replace
Membrane				X				Replace. Sooner if signal will not stabilize
Spill housing and stirrer	X							Clean